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THE AUSTRALIAN ZOOLOGIST

Vol. XI. Part I.

NEW SHARKS AND FISHES FROM WESTERN AUSTRALIA.

PART 2.

By GILBERT P. WHITLEY, F.R.Z.S.

(Plate i. and text-figs. 1 to 15.)

Since my paper on "New Sharks and Fishes from Western Australia" was published in the "Australian Zoologist" in May, 1944, and some fishes were illustrated in the "Proceedings" in August, I have spent a further period working in the field in Western Australia and have been fortunate enough to obtain specimens of several species of sharks hitherto known only from incomplete specimens or from photographs. I am now able to describe and figure these species in fuller detail and give some data on their food and breeding. Some new or little known fishes are also described or figured for the first time, often from living or fresh examples. Two new families, one Berycoid and the other proposed for an interesting blind gudgeon, and more than 20 new genera, species, etc., are named.

Mr. L. Glauert, Director of the Western Australian Museum, kindly afforded me facilities for working on the fish collections in Perth, enabling the preparation of a manuscript list of the fishes of the State, including many new records. Miss M. Johnston and Miss B. Carter, of the State Fisheries Department, Perth, typed the paper for publication.

Family GALEIDAE.

GALEOLAMNA GREYI, Owen.

(Fig. 1.)

The typical species of the genus *Galeolamna* are whaler sharks with the head 4 to 4.8 in total length, nostrils nearer mouth than end of snout, teeth notched and serrated, preoral length notably less than width of mouth, and *lacking an interdorsal ridge;* the middle of the vent is usually in the posterior half of the shark. The Western Australian forms of this group may be subdivided as follows into geographical subspecies:

A. Fifteen or sixteen teeth on either side of the symphysial tooth in each jaw. .. .. *G. greyi greyi,* Owen (South Australia to Bunbury).

AA. Twelve to fourteen teeth on either side of the symphysial one in each jaw.

B. Snout bluntly rounded.

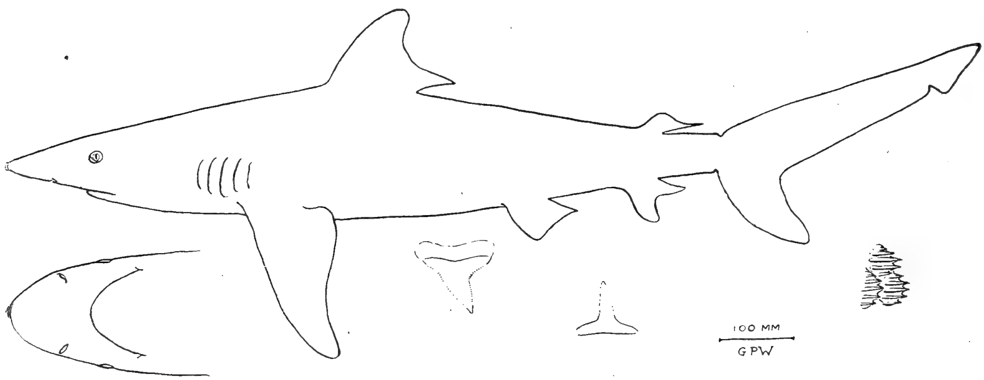
Anal origin and end of its base behind levels of those of second dorsal. Pectoral angle under first dorsal fin. Dermal denticles

with three keels. .. .. *G. greyi mckaili,* subsp. nov.* (Swan River district).

BB. Snout more acutely rounded.

Anal origin and end of its base before levels of those of second dorsal. Pectoral angle well in advance of level of first dorsal. Denticles with five keels. .. .. *G. greyi cauta,* subsp. nov. (Shark's Bay to Point Cloates).

Figured herewith (Fig. 1) is a typical *G. greyi greyi* from Esperance, a female, 1,301 mm. long and weighing 27 lb.



1. Whaler Shark, *Galeolamna greyi greyi,* Owen. A female from Esperance. Also teeth and dermal denticles.

GALEOLAMNA GREYI CAUTA, *subsp. nov.*

(Fig. 2.)

A female whaler shark, 918 mm. long, netted in Herald Bight, Shark's Bay, Western Australia, on 5th August, 1943, agrees fairly well with my description (Fish Austr., i., 1940, p. 273, fig. 303) of a male Swan River whaler, 806 mm. long, but presents some noteworthy variations.

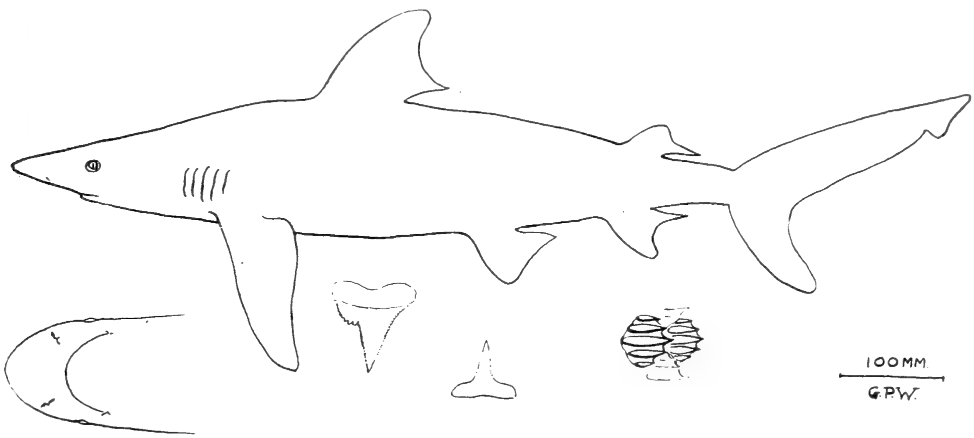
The female has head 4.4 in total length, snout rather more acute, predorsal gibbosity less marked, the shallow convex interorbital comparatively narrower, and preoral length (59 mm.) much less than width of mouth (78). Dental formula:—

$$\frac{14.1.13}{12.1.13} = \frac{28}{26}.$$ Teeth of both jaws serrated, that on each side of symphysial tooth smaller than its outer neighbours (the teeth are fewer than in the holotype of *G. greyi* in which there are 15 or 16 on each side

---

* Holotype of this new subspecies was described and figured in my "Fishes of Australia," i., 1940, p. 273, fig. 303 (not fig. 88, No. 5). It is now named in honour of the late Henry Lancelot Martin McKail, who was keenly interested in its identity and who informed me that it was known as the Bluenose on the Swan River because of a dark blue mark on the snout.

of each jaw. Those of upper jaw are slenderer than those of Owen's type. In *Galeolamna eblis* the dental formula is usually 14.1.14 in each jaw, but that species has an incomplete interdorsal ridge).



2. Nervous Shark, *Galeolamna greyi cauta*, Whitley. Holotype of subspecies from Herald Bight, Shark's Bay. Also teeth and dermal denticles.

The third gill-slit is longest; last two gill-slits over pectoral. Dermal denticles with five keels reaching the edge, which is slightly scalloped. Nostrils acutely lobed, lobes nearly 8 mm. long.

Anal origin and end of its base in advance of level of those of second dorsal instead of behind as in Swan River male. Pectoral fin shorter and its angle well in advance of level of first dorsal. Ventral base mostly in anterior half of shark.

No interdorsal ridge. Lateral line inconspicuous. Caudal pit above and below.

*Measurements in millimetres.**

H.1	169	F.1	135
2	206	2	88
3	73	3	43.5
4	97	4	209
5	209	5	53
6	440	6	44
7	17.5	7	38
8	12	8	76
9	98	9	59
10	—	10	47
11	15	11	35
12	51	12	72

* For explanation of symbols, see Proc. Linn. Soc. N.S. Wales, lxviii., 1943, p. 114.

13	59	13	vide descr.
14	78	14	155
15	4	15	52
16	notch	16	257
17	26	17	64
18	17	18	51
B.1	680	19	37
2	470	20	124
3	293	21	238
4	135	22	117
5	118		
6	34		
7	32		

Eye to first gill-opening ..	88
Snout from nostrils	42
Nostril to mouth	34

Colour: Dark grey above, white below. A few white round spots on right side behind pectoral. A dark bar along sides. Anterior margins of dorsals and caudal dusky. Caudal margin and tip of lower lobe blackish. Pectoral and ventral dusky superiorly; anal dusky anteriorly. Eye pale olivaceous and greyish, with pale grey ring. Dorsal and other fin axils white.

Vertebrae 160. No. 25 below first dorsal origin, 66 below second dorsal origin, 90 to the upward tilt of caudal axis and 70 more along the caudal fin to No. 160.

Liver weight 2 lb. Mesovarium and shell glands small, uteri thin and undeveloped, thus quite immature. The stomach contained some very digested fish remains, probably whiting (*Sillago*).

Described from an immature female specimen, slightly more than three feet long and 11 lb. in weight. Many specimens were swimming about at the time, but though my companions and I tried to wade near them, we were unable to get close and only managed to net one of the school.

This is the "Nervous Shark" of my "Fishes of Australia" (i., 1940, p. 105), but it has serrated teeth quite unlike the entire teeth shown in my fig. 103, which is referable to another species, *Mystidens innominatus* Whitley, 1944.

I noted more than 40 further specimens of *G. greyi cauta* from Shark's Bay in August and September, 1944. This shark breeds at less than four feet in length, embryos being about a foot long, each weighing about 4 ounces, compared with the 12 lb. approximate weight of mother.

In *G. greyi greyi,* breeding does not take place until a greater length, a female specimen 1,301 mm. long and 27 lb. in weight from Esperance, W.A., being immature.

The food of *G. greyi cauta* in Shark's Bay consists of various kinds of fishes, *Saurida, Sillago,* and *Dasson,* and a crab (*Lupa*) having been identified in the stomachs; they also took baits of Tailor (*Pomatomus*).

GALEOLAMNA DORSALIS, Whitley.

(Fig. 3.)

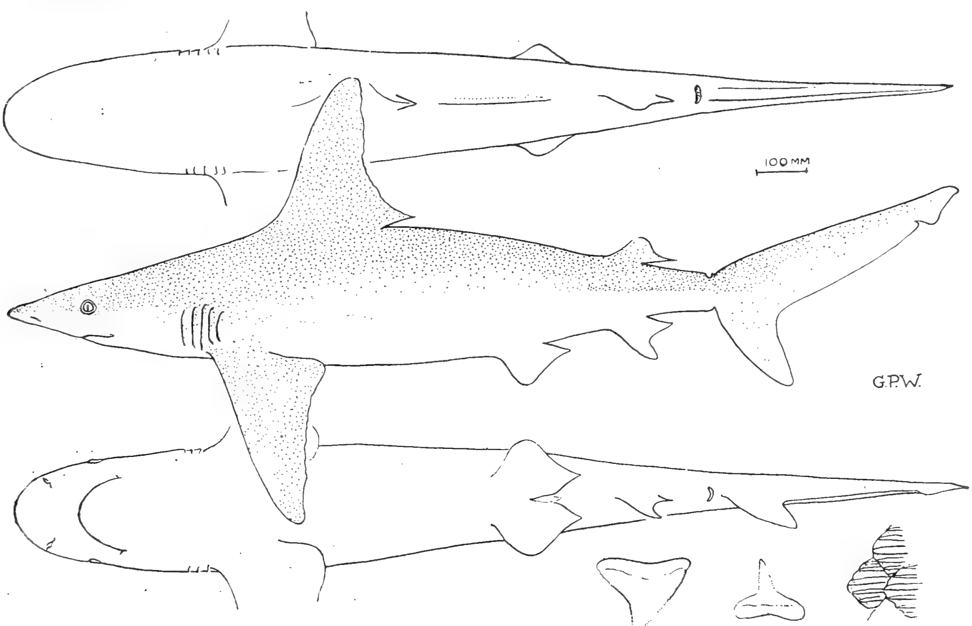
Galeolamna dorsalis Whitley, Austr. Zool., x., 3, May 10, 1944, p. 256, fig. 3, Carnarvon, W.A.

This species, hitherto known only from photographs and notes, was encountered in Shark's Bay, in August and September, 1944. Altogether 28 specimens, 5 ft. 5 in. to 6 ft. 7 in. long were caught. Some of the females were gravid, the embryos being in separate compartments, others had evidently bred. From five to ten embryos constitute a brood, each between 15¼ and 17¼ in. (388 to 438 mm.) long. I saw one female caught off Bunbury, the southernmost limit.

A female specimen, 1,890 mm. long and weighing 100 lb., from Dirk Hartog Island, is here figured. Its ovaries extended most of the length of the coelome, no ova were visible and the uteri were flaccid, so it had perhaps bred some time previously.

General colour pale grey above and parchment white below; iris pale bronze.

The presence of an interdorsal ridge which becomes obsolete before reaching either dorsal fin (as in *G. eblis* Whitley, to which this species is



3. Sand Shark, *Galeolamna dorsalis*, Whitley. Female from Dirk Hartog Island. Dorsal, lateral and ventral views; teeth and dermal denticles.

most closely allied) is noteworthy, but *dorsalis* is always separable from *eblis* by its higher dorsal fin. In *dorsalis* the distance from the origin of the first dorsal fin to its tip goes about 5 to 5½ times in total length, but in *eblis* it goes 8 to 9 times in the same. The head of *dorsalis* is generally about 4½ to 5½ in total length, rarely 4 or less, as in *eblis*. In *dorsalis* the pectoral fins are very long, the second dorsal fin is larger and pectoral angle further back than in *eblis*. It seems likely that *eblis* breeds at a much larger size and has much larger embryos, but I have incomplete data on

this score. Females 7 to 9 ft. long at Bunbury (January, 1945) were immature.

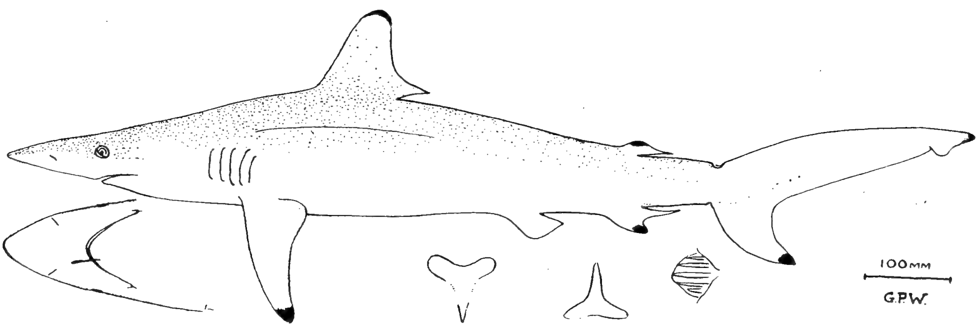
Galeolamna dorsalis feeds on various fishes and crustacea, but digestion is so rapid that identification of stomach contents is usually impossible and many specimens are empty. Apart from prawns, crabs, octopus and pipefish remains, I found the following fishes in this shark: *Cybium queenslandicum, Amphacanthus nebulosus, Parapercis, Amphitherapon, Sillago,* a Clupeid, probably *Sardinops,* and a small elasmobranch. Fish-baits taken were *Himantura, Mugil, Chrysophrys* and *Pomatomus.*

LONGMANIA CALAMARIA, Whitley.

(Fig. 4.)

Longmania calamaria Whitley, Austr. Zool., x., 3, May 10, 1944, p. 257, fig. 4. Busselton, W.A.

This species, hitherto known only from the incomplete type specimen, was encountered in Shark's Bay in August, 1944, when two males and five



4. Inkytail, *Longmania calamaria,* Whitley. Female from Dirk Hartog Island. Also ventral surface of head, upper and lower tooth, and dermal denticle.

females, 1,000 to 1,255 mm. long, and all immature, were examined. It is now possible to illustrate the whole shark, the accompanying figure showing an immature female, 1,120 mm. (3 ft. 9 in.) long and weighing 6 lb. 2 oz., from Dirk Hartog Island. The long snout, black-tipped fins, small second dorsal fin, and more than fifteen teeth on each side of each jaw are characteristic. The teeth are serrated in upper, entire in lower jaw. Dental formula $\frac{16.2.16}{16.15.?}$. The pectoral angle in some extends to below the very anterior part of first dorsal fin.

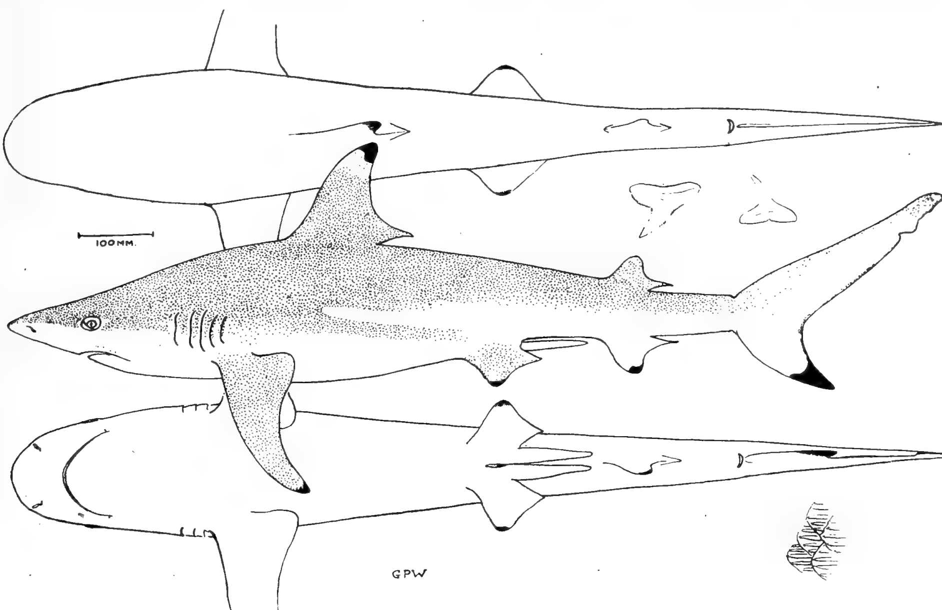
Stomachs contained a variety of fishes such as whiting (*Sillago*), pilchards (*Sardinops*), herring (*Escualosa*), marbled flathead, small stingray, tailor (bait), etc.

This species occurred at Bunbury in November, 1943, and January, 1945.

Genus Mapolamia Whitley, 1934.
Mapolamia spallanzani (Le Sueur).
Black Tip Shark.
(Figs. 5 and 5a.)

Squalus spallanzani Le Sueur, Journ. Acad. Nat. Sci. Philad., ii., November, 1822, p. 351. Terre de Witt, New Holland.

The Black Tip Shark is not likely to be confused with more than one or two other species of Western Australian sharks. The brownish colour, black tips to most fins, blunt snout, lack of interdorsal ridge, rather large second dorsal fin, and the thirty or less serrated and notched teeth across each jaw are characteristic. In the Inkytail Shark (*Longmania calamaria*),



5. Black Tip Shark, *Mapolamia spallanzani* (Le Sueur). Male from near Yardie Creek, North-west Cape.

the snout is longer and more pointed, the second dorsal fin is small and low and there are more than thirty teeth across each jaw, these being either minutely or not at all serrated. Some of the Whaler Sharks (*Galeolamna* spp.) occasionally have dark or dusky tips to their fins, but can be distinguished by a combination of other characters such as the presence or absence of an interdorsal ridge, sharpness or roundness of snout, number and form of teeth, relative positions of second dorsal and anal fins, extent to which pectoral angle reaches below first dorsal fin, etc. Compare these features in the accompanying figures.

Description of Male.

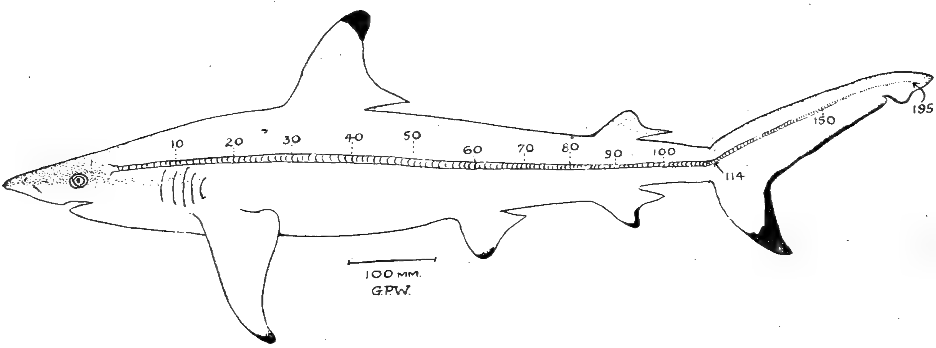
Predorsal profile not gibbous. Eyes large, ovate with nictitating membrane; pupil lenticular. Interorbital broad, weakly convex. Pupil of eye on

level with anterior part of mouth. Snout bluntly rounded. Head 4.3 in total length. Preoral length much less than width of mouth. No spiracle.

Teeth of upper jaw with their points deflected outwards, their inner margins oblique and scarcely notched, their outer margins deeply notched. They are serrated on shoulders and fangs, the serrae being largest on the outer shoulders. Teeth of lower jaw notched on both sides, with more erect fangs, minutely serrate. Bases of teeth usually wider than the teeth are high.

$$\text{Dental formula: } \frac{10? + 2? + 12}{11.1.1.12} = \frac{24?}{25}$$

Last two gill-slits over pectoral fin. Nostrils nearer mouth than end of snout, their lobes rounded, 5 mm. long. Labial folds short. Endolymphatic openings inconspicuous.



5a. Black Tip Shark, *Mapolamia spallanzani* (Le Sueur). Female from Winderabanda, North-west Cape, showing disposition of vertebrae.

Body rather deep, widest anteriorly. Lateral line inconspicuous. No interdorsal ridge. No keel on the caudal peduncle, which is rather broad. A lunate caudal pit above and below. Hide thick and tough. Shagreen with denticles imbricate, each with its free margin barely reached by its five transverse carinae.

Claspers well developed.

Measurements: Following the symbols devised in my scheme of biometric measurements, published in Proc. Linn. Soc., N.S. Wales, lxviii., 1943, pp. 114-115, the dimensions in millimetres are as follows:—

H.1	229	B.1	980	F.7	41
2	290	2	c.650	8	98
3	102	3	400	9	67
4	129	4	200	10	67
5	290	5	c.150	11	42
6	628	6	49	12	101
7	25	7	46	13	(vide fig.)
8	14	8	100	14	220
9	134	9	124	15	72
10	(no spiracle)	F.1	168	16	355
11	18	2	119	17	79

12	72	3	59	18	89
13	69	4	310	19	35
14	114	5	62	20	198
15	4.5	6	58	21	290
16	2.5			22	150
17	43				
18	39				

Additional measurements are:—

Total length: 1,265 mm. or about 4 ft. 3 in.
Distances between gill-openings: 23, 15, 13 and 13 mm.
Deepest (third) gill-opening: 57.
Eye to first gill-opening: c. 124.
Snout to level of angles of mouth: 129.
Ramal length: 85.
Tip of snout to outer angle of nostril: 56.
Inner angle of nostril to mouth: 42.
Origin of first dorsal to that of pectoral, 206; to that of ventral: 288.
Depth above ventral origin: 145.
Depth above ventral end: 104.

Fins: First dorsal with anterior margin not very strongly curved. Second dorsal rather large for a Galeid shark. Anal larger than second dorsal, its origin in advance of level of that of second dorsal, but their bases end level. Pectorals long and well curved, the last ray (= pectoral angle) below anterior part of first dorsal fin. Ventrals rather large, at middle of shark. Subcaudal notch high and small. Anterior margins of all fins trenchant, not flattened. Lower caudal lobe pointed. Upper caudal lobe equals head in length.

Colour: In life brownish with bronze to olivaceous tones, greyer along back and on a band extending downwards and backwards along sides from below first dorsal fin to above ventrals. The junction of the dark upper colours with the lighter dull yellowish of the flanks is mostly below level of eye, though interrupted below the eye itself. Eye grey to brownish; pupil black with a white outer ring. Dorsal axils grey. Conspicuous black tips to first dorsal, pectoral, ventral and anal fins and to lower caudal lobe. Anterior edges of dorsal and caudal fins dark brown. A lighter tone below the black tip to first dorsal. Upper surfaces of ventrals and pectorals greyish. Second dorsal fin and upper caudal lobe infuscated. Ventral surfaces and claspers white.

Vertebrae 193, the backbone being straight as far as tail, without lateral curvature, or any notably enlarged thoracic vertebrae. Vertebra number 30 was below origin of first dorsal fin, No. 57 over ventral origin, 86 over anal origin, 87 under second dorsal origin, 95 between ends of bases of second dorsal and anal fins, 113 to base of caudal. Last vertebrae very small.

Liver dark and in good condition. Testes length of coelome, the right one swollen anteriorly; vesiculae seminales stored with sperm. Stomach contained few minute fragments of some indeterminable fish.

Described and figured from a mature male specimen, 1,265 mm. or about 4 ft. 3 in. long, which I speared in shallow water in the sea near Yardie Creek, North-west Cape, Western Australia, on 8th October, 1944.

Description of Female.

In all general respects, similar to male, but with the following noteworthy features: Head 4.7 in total length.

Widest part of head near first gill-opening. Tongue smooth and rounded, not notched.

$$\text{Dental formula: } \frac{12.2.12}{11.1.11} = \frac{26}{23}.$$

Tooth on each side of symphysial one in lower jaw much smaller, in upper rather smaller than the outer neighbouring teeth.

Abdominal pores large. Pit-organs conspicuous. Pectoral fin comparatively shorter ($15\frac{1}{2}\%$ of total length in female, 17 in male).

Origin of first dorsal fin to that of pectoral, 160 mm.; to ventral, 240. Pectoral axil to origin of ventral, 265; distance between pectoral origins, 128.

Distance between gill-openings: 15, 11, 11, and 11. Longest (third) gill-opening, 44. Eye to first gill-opening, 102. Snout to level of corner of mouth, 107. Ramal length, 69. Snout to nostril, 45; nostril to mouth, 36.

Biometric measurements of female:—

H.1	=	186	F.1	=	142
2	=	228	2	=	98
3	=	80	3	=	52
4	=	106	4	=	268
5	=	232	5	=	54
6	=	520	6	=	47
7	=	21	7	=	41
8	=	13	8	=	88
9	=	109	9	=	60
10	=	—	10	=	53
11	=	15	11	=	31 (tip damaged?)
12	=	57	12	=	86
13	=	62	13	=	(as in male)
14	=	90	14	=	170
15	=	6	15	=	55
16	=	2	16	=	310
17	=	37	17	=	65
18	=	28	18	=	58
B.1	=	820	19	=	35
2	=	560	20	=	150
3	=	330	21	=	270
4	=	142	22	=	124
5	=	130			
6	=	40			
7	=	39			

Colour as in male described above, but with the dark overtone level just below the eye whose pupil is darker grey; tips of ventrals and all the posterior margin of caudal fin black; second dorsal with dark-edged (not black) tip; nictitating membrane bluish-white.

Liver weight 12 oz., about 5% of total weight. Mesovarium pale, almost as long as coelome; uteri mere shreds, shellglands very small. No embryos or ova evident. Stomach contained a bitten cuttlefish, or squid head.

Vertebrae 195. No. 30 below first dorsal origin, 58 over ventral origin, 84 over anal origin, 86 under second dorsal origin, 95 between ends of second dorsal and anal bases, 114 at base of caudal, and 172 over upper caudal notch (see fig. 5a).

Described from an immature female, 1,090 mm. or 3 ft. 7½ in. long; weight 14½ lb., caught by handline (mullet bait).

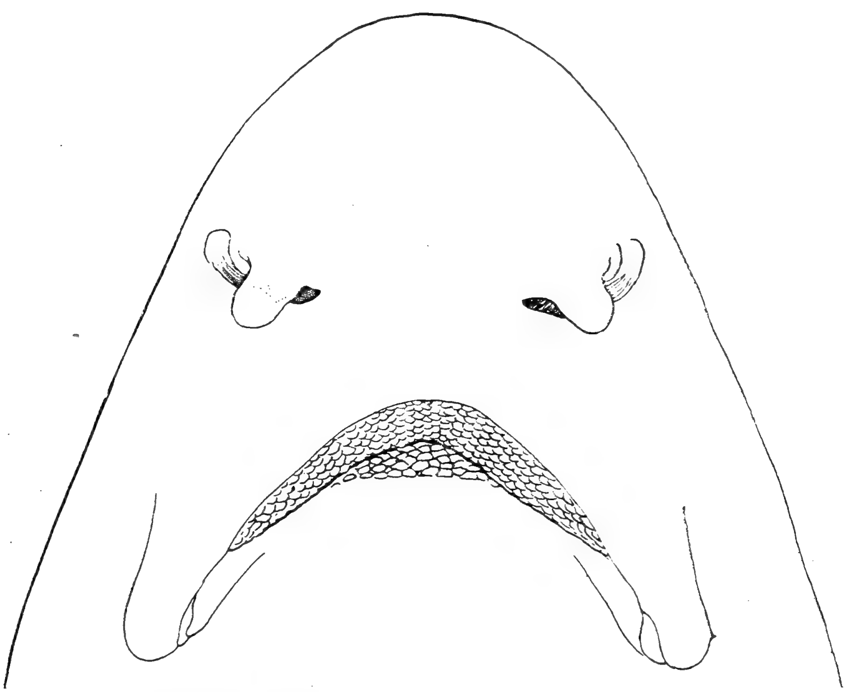
Locality.—Winderabanda Beach, eleven miles north of Point Cloates, Western Australia; 12th October, 1944.

Family Emissolidae.

Emissola ganearum, *sp. nov.*

(Fig. 6.)

The giant size of Western Australian gummy sharks at once strikes an observer accustomed to the gummies of the eastern States. Thus, in New



6. Gummy, *Emissola ganearum,* Whitley. Ventral surface of head of holotype, off Bald Head, Albany. G.P.W. del.

South Wales, hundreds of specimens caught in various months by the trawlers, did not exceed 900 mm. in total length for males and 1,250 for females. Males usually measured between 750 and 800 mm., and females between 850 and 900. In New South Wales, the males out-numbered females by about 73 per cent.

In Western Australia, between June, 1943, and February, 1944, I saw numerous specimens caught around Esperance, Albany and Bunbury by set-lines. In these, the largest male was about 1,270 mm. long, and the largest female 1,570. Males usually measure less than 1,150 mm., and females between 1,250 and 1,350. In Western Australia, adult females outnumber males by about 13 per cent. in the commercial catches. In litters of embryos, however, males sometimes outnumber females (cf. Haacke, Zool. Garten, xxvi., 8, August, 1885, p. 247, on this ratio). When tagging sharks in southern Tasmania, however, I found 87.5% of this genus were males.

These striking numerical discrepancies suggest at least a racial differentiation for the W.A. stocks, but there are other differences as well, the most important being the absence of partitions separating the embryos in the uterus, so that a new specific name is necessary.

The size, colour, and numbers of embryos vary, too. In the gummies of New South Wales, 3 to 7 embryos are the usual brood. In the Western Australian sharks, there may be almost any number from 4 to 22, but there are rarely fewer than twelve; both the developing ova and the embryos are larger in the Western sharks, being full-term at from about 9 to 13 inches in length. The embryos vary in size at the same time of year in different mothers and are sometimes accompanied by a few infertile eggs. The embryos are usually plain greyish, without the transverse dark bars characteristic of Eastern Australian specimens.

About 75 to 80 teeth across each jaw, all blunt, those of lower jaw with some ridge-like crowns. Upper labial fold the longer. Third gill-slit longest. Spiracles fairly large in young, small and slit-like in adults.

Pectoral fin further forward than in *E. maugeana* Whitley, from Bass Strait, its angle below anterior portion of first dorsal fin. Lower caudal lobe rounded. Upper caudal lobe less than head in length. General colour greyish with white spots on back and along lateral line. Young examples sometimes with dark edge to dorsal. Iris bronze to greyish.

Feeds on various crustacea (spider, sand, hermit and swimming crabs, shrimps, king prawn, raninoid), sea mouse, sipunculid worms, octopus, squid, sharks' and skates' eggs, and fishes (*Phyllopteryx, Parapercis,* catfish, parrot fish, yelloweye mullet, etc.).

The liver weight varies from 4 to 10% of the whole weight.

Localities.—Holotype from off Bald Head, Albany, W.A.; 5 October, 1943. Female, 1,400 mm. in total length (head figured here). Weight over 40 lb. Had 22 embryos, mostly (15) female, 300 to 362 mm. long; umbilical scar present, no yolk-sac.

Doubtful Island Bay, east of Albany, W.A.; 30/11/11, F.I.V. "Endeavour" (Austr. Mus., No. E.2316). Female 283 mm., with umbilical scar healed.

Albany, W.A. (Austr. Mus., No. IA.672). Female, 335 mm. long, with umbilical scar healed.

Many specimens seen from off Bunbury, Albany, and Esperance, Western Australia, and in the Perth fish markets.

Cynias lenticularis (Phillipps), the white-spotted Gummy of New Zealand, differs from those of Western Australia in having larger spots and more acute snout; the nostril flaps have the posterior margin longer than the lateral instead of being semicircular as in the Western Australian form, and the spiracles are smaller than in *ganearum* of comparable size.

Family ECHELIDAE.

MURAENICHTHYS BREVICEPS, Gunther.

Depth (15) 3.2 in head (49) which is 11.4 in total length (560) and 3.4 in space between gill-opening and vent (169). Eye (6) 1.6 in snout (10) and 8.1 in head, less than interorbital (6.5). Cleft of mouth (17) 2.8 in head. Gill-openings (3) 2 in eye, and 15 mm. apart ventrally. No fringes on lips. Teeth biserial along vomer and in narrow strips about 2 rows wide along jaws.

Cannot see jujostegalia through integument.

Snout to vent (215) 1.6 in tail (345). Predorsal length (98) much less than distance from dorsal origin to end of tail (462). Origin of dorsal to level of vent (117) much more than head. Anal fin commencing just behind vent, confluent with caudal and dorsal, the latter extending well in advance of level of vent.

Dark greyish brown above, whitish below. The junction rather strongly marked below middle of sides, along lower level of gill-slits and lower level of eye. Some yellow on cheeks, throat and chin. Most of mouth white, tips of jaws dark greyish brown. Eye dull bluish. Dorsal fin dirty greyish with a yellowish tinge anteriorly, but this gives way posteriorly to a brighter yellow. Anal dull whitish with some yellow posteriorly. Caudal brown.

Described from a specimen 560 mm. or 22 inches long.

Locality.—Albany, Western Australia. March, 1944. W.A. Mus., Regd. No. P.2604.

This species of Worm Eel, originally described from Tasmania, is known also from Victoria and South Australia. This is the first time it has been recognised from Western Australia.

It can be readily distinguished from *Scolechenchelys* by having the dorsal fin originating well in advance of the vent, cleft of mouth about one-third of head, teeth in more than one series along jaws and vomer, predorsal length much less than rest of fish, and distance from origin of dorsal fin to level of vent much more than length of head.

The species is well illustrated in Waite's "Fishes of South Australia," 1923, p. 73.

Family BELONIDAE.

Genus DJULONGIUS Whitley, 1935.

DJULONGIUS GAVIALOIDES (Castelnau).

(Fig. 7.)

Belone gavialoides Castelnau, Proc. Zool. Acclim. Soc. Vict., ii., May 10, 1873, p. 142. Fremantle, W.A.

Belone groeneri Klunzinger, Sitzb. Akad. Wiss. Wien., lxxx., 1, 1879, p. 414. Port Darwin, Northern Territory. (New Synonym.)

Br. 13; D.i., 20; A.i., 20; P.i., 13; V.i., 5; C.13 branched.

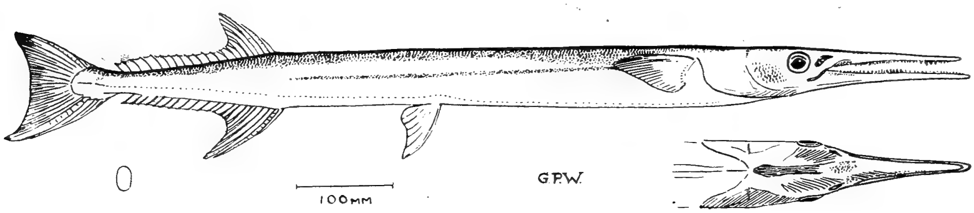
Head, from end of lower jaw, 273 mm.; from upper, 265. Eye, 25; interorbital, 46. Dorsal base, 162; its lobe, 71. Anal base, 156; its lobe, 86. Last dorsal ray, 11; last anal ray, 13. Predorsal length, 714. Snout to origin of ventral, 542. Pectoral, 85; its base, 28. Pectoral origin to ventral origin, 265. Ventral fin, 63. Ventral origin to anal origin, 163. Middle caudal

rays, .43. Depth of body anteriorly, 62; at ventrals, 55. Depth of caudal peduncle, 22; width of same, 18.

Upper jaw included. Teeth juxtaposed, about vertical, or sloping slightly backwards. Palate toothless. Tongue rough. Maxillary mostly concealed under preorbital. Middle of interorbital concavely excavated. No gill-rakers. Scales in numerous rows on cheeks, none on operculum. Body not greatly compressed. No keel on caudal peduncle, which is deeper than broad.

Anal origin in advance of that of dorsal. The anal lobe is higher than that of the dorsal, but its posterior rays are rather lower than the dorsal ones; second anal ray longest; second pectoral ray longest.

Colours (in life): Light sea-green above (three faint blue lines along top of back), gradating to silvery white below. A dark bluish-green band



7. Long Tom, *Djulongius gavialoides* (Castelnau). Female from Dirk Hartog Island. Also transverse section through caudal peduncle and dorsal view of head.

extends back from upper portion of operculum and pectoral base along middle of side to between dorsal and anal origins. Mouth white, with silver, blue and pink tinges; teeth white. Tips of jaws fleshy or pinkish. Pupil black; iris very pale yellowish with green above. Cheeks and chin silver. Fins very pale green or almost white. Slight dark grey margins to dorsal and caudal lobes. Pectoral watery yellowish, with dark smoky grey upper margin and distal third. A smoky blotch at upper part of inner pectoral axil.

Described and figured from a female specimen, 1,000 mm. long and weighing 3¼ lb. The stomach was very large, empty. Ovaries well-developed with discrete ova and blood vessels; gonad weight, 1 oz. Swim-bladder carrot-shaped with scalloped edges. The described specimen was the largest of several, 960 to 1,000 mm. long; weight, 3 lb. to 3 lb. 13 oz.

Locality.—East coast of Dirk Hartog Island, Western Australia. Seined, 17th August, 1944. Coll. G. P. Whitley.

A small example was secured at Point Cloates on 30th September, 1944. Total length, 590 mm.; caudal peduncle with a slight keel on each side; D.i., 20; A.i., 20. Regd. No. P.2798.

Family Mugilidae.

Moolgarda, *gen. nov.*

Orthotype, *Moolgarda pura,* sp. nov.

Mullets with the adipose eyelids obsolescent, not nearly covering one-third of eye posteriorly. Snout longer than eye. Interorbital convex.

Mandibulary angle very obtuse. Upper jaw terminal. Upper lip moderately thick with microscopic cilia or entire, not papillose. Jaws toothless. Free space along chin between opercles almost closed. Preorbital margin serrated. Slope of opercular margin steep. Gill-rakers numerous. Rostrodorsal profile not remarkably convex. Depth about 4 to 4½ in standard length. Scales in about 30 to 35 transverse series between head and hypural joint. About 21 predorsal scales. First dorsal origin nearer snout than caudal base. Second dorsal and anal origins about opposite or anal slightly anterior. Anal fin with nine soft rays. Pectorals not elongated, their base at or over middle of body. Axillary scales present. Depth of caudal peduncle less than or subequal to half head.

The above combination of characters distinguishes this genus from all others in the family. It seems, however, closest to the group known as *Liza*. The name *Liza*, Jordan and Swain (Proc. U.S. Nat. Mus., vii., 1884, p. 261) was proposed for Old World mullets in which the adipose eyelids were obsolete. The genotype was the European Grey Mullet, *Mugil capito* Cuvier, which, according to Gunther (Cat. Fish. Brit. Mus., iii., 1861, p. 439), differs from the Australian fish here diagnosed in having the mandibulary angle much less obtuse, the space between opercles on chin obtusely rounded anteriorly and more open, the maxillary exposed, and in having many more scales (45 or 46) along body and (28 or 30) predorsally; there are other differences in proportions of head and body, so that the best course to pursue is to provide a new name for the Australian fish.

Besides the genotype, the two mainly eastern Australian species, *"Mugil" argenteus* Quoy and Gaimard, and *M. compressus* Gunther, may tentatively be included in the new genus, *Moolgarda*, though at the time of writing, I have no specimens of these at hand. Gunther (*loc. cit.*) describes them as having L. tr. 10, flatter interorbitals, no axillary pectoral scales and with very different proportions, etc. *Moolgarda compressa* has the maxillary exposed, but *M. argentea* has the maxilla hidden.

MOOLGARDA PURA, *sp. nov.*

Brown-back Mullet.

(Fig. 8.)

D.iv./i., 8; A.iii., 9; P.ii., 16; C.14 branched. Sc. 36 to hypural joint and 5 on caudal base. Tr. 14. Predorsal 21. Ten scales down side of caudal peduncle and 6½ between dorsal fins.

Head (100 mm.) 3.9, depth (92) 4.2 in standard length (390). Snout (24) 4.16, eye (17) nearly 5.9, interorbital (48) 2 in head. Internarial, 32; width of head, 69; pectoral, 86; postorbital, 55; depth of caudal peduncle, 39; length to caudal fork, 440; total length, 490 mm.

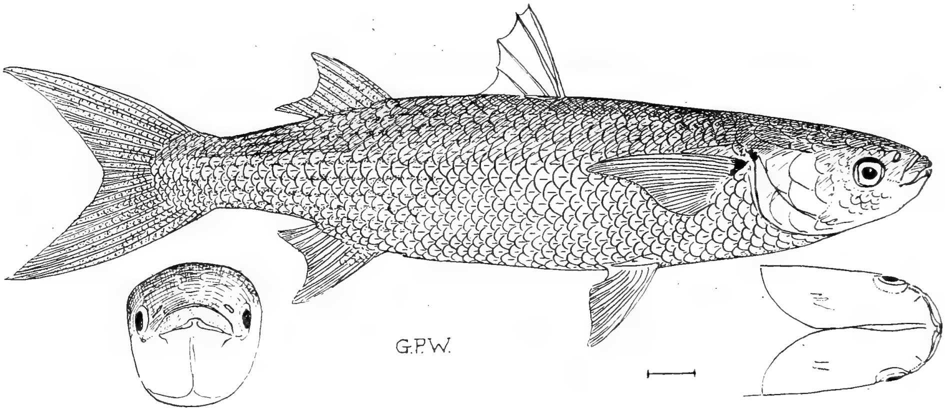
Snout broadly rounded, not excavated.

Three rows of cheek scales; a couple of notched scales near preopercular angle. Four notches across vertex and along grooves over opercles. A groove before vomer.

Cleft of mouth broader than deep. No teeth on jaws or palate. Jaws protusible. Upper lip deep; lower slender with double symphysial knob. Lips without papillae or visible cilia, with cultrate edges and no transverse groove. Maxilla sheathed under preorbital when mouth is closed, reaching to below the posterior nostril on each side. Nostrils nearer one another than to eye. Preorbital serrations obsolescent.

Eye situated rather low. Adipose eyelids not nearly reaching pupil. Interorbital broadly convex, scaly. Opercles close together along median line; posterior margin of operculum subvertical. Gill-rakers slender, about 68 on lower part of first branchial arch.

Body rather slender, its maximum depth at origin of first dorsal fin, its width greatest where it joins head, the dorsal profile weakly convex. Scales large, cycloid, with clear entire distal margins and about five basal radii. Large axillary scales to paired fins. Small scales extend over



8. Brown-back Mullet, *Moolgarda pura,* Whitley. Holotype from Point Cloates. Also anterior and ventral aspects of head.

pectoral and caudal fins proximally. Soft dorsal and anal fin only scaly anteriorly. Each scale of body with central streak; most of head scales without these.

Origins of dorsal fins over 14th and 26th body scales. First dorsal origin midway between tip of snout and hypural joint. First dorsal spine reaching more than half its distance from second dorsal fin. Anal origin behind level of that of second dorsal. Pectoral shorter than head, not reaching level of first dorsal spine, extending to 11th body scale. Caudal forked.

Colour in life, brownish on top of head and anterior part of back. Generally greyish elsewhere to silvery or white below. Some faint stripes of darker grey along junctions of scale rows. Eye whitish with black pupil and a yellow crescent over upper part of iris. Fins mostly greyish; ventrals white; pectorals light olivaceous-yellow with conspicuous blue axillary blotch; caudal with brilliant blue iridescence.

Described and figured from a female specimen 490 mm. (about 19½ inches) long. Gonads at stage IV or late III of G. Kesteven's classification (C.S.I.R. Bull. 157, 1942, p.48).

Locality.—Point Cloates, Western Australia; in schools in shallow water over sand, 6th October, 1944.

Native name: Moolgarda.

Variation.—A series of co-types, up to 665 mm. in total length, from Shark's Bay, Exmouth Gulf, Onslow and Broome, Western Australia, exhibits

little variation. The maxilla may be exposed in some examples and the anal origin a little in advance of level of second dorsal origin. Larger specimens have these fins scaly all over. The transverse rows of scales vary from 29 to 35 between head and hypural and are not always bilaterally equal in number. Axillary scales were absent from the pectoral in one specimen. The l.tr. varies from 11 in small to 15 in large specimens. The species grows to at least 26 inches long and is said to be common in shallow water all the year round. It is the Yellowfin Mullet of Shark's Bay (because of the yellowish pectoral fins) but I think Brown-back Mullet would be a preferable vernacular name because the brown backs are very characteristic as these fishes are seen swimming near the surface in shallow water.

Subgenus PLANILIZA, *nov.*

Orthotype, *Moolgarda (Planiliza) ordensis,* sp. nov.

A mullet in general similar to the new genus *Moolgarda* described above, but distinguished by having (1) the interorbital broad, flat and depressed; (2) the free space along chin between interopercles broadly open; (3) only about sixteen predorsal scales, and (4) with anal origin in advance of level of second dorsal origin. There are many minor differences as well, e.g., large axillary scales are not developed at the pectoral fins, the body scales are larger and fewer, and small scales extend over most of the fins.

MOOLGARDA (PLANILIZA) ORDENSIS, *sp. nov.*

Ord River Mullet.

(Fig. 9.)

D.iv./i., 8; A.iii., 9; P.ii., 16; C.12 branched. Sc. 31 to hypural + 2 large and several small on caudal. L.tr., 11. Predorsal 16. Seven or eight scales down side of caudal peduncle and between dorsal fins.

Head (84 mm.) 3.8, depth at first dorsal origin (75) 4.3 in standard length (325). Snout (26) 3.4, eye (13) 6.8, interorbital (40) 2.2, and depth of caudal peduncle (35) 2.5 in head.

Depth of cleft of mouth (6.5) 4.3 in its width (28). Distance between anterior nostrils, 23; width of head, 61; length of pectoral, 55; trunk, 140; distance between origins of dorsal fins, 86; head without snout, 67; first dorsal spine, 36; postorbital, 52; length to caudal fork, 370; total length, 390 mm.

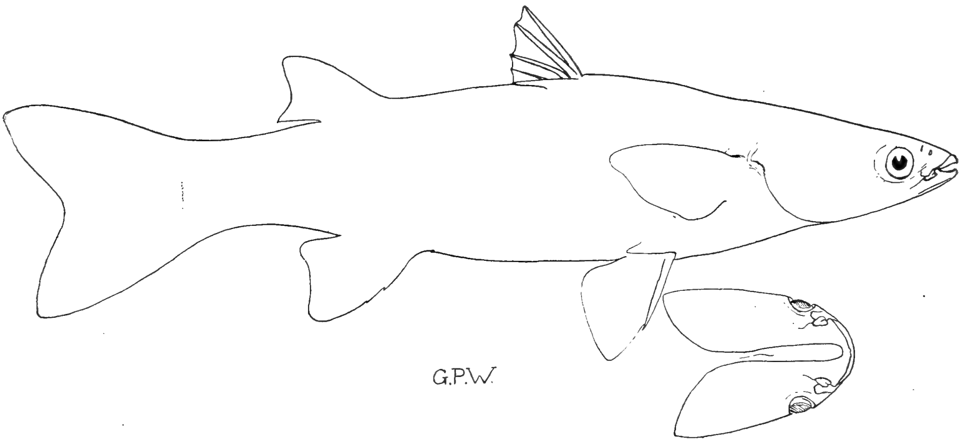
Head elongate, very depressed, its depth about half its length, its profile acute-angled; snout broadly rounded. Four rows of cheek-scales. Two weakly notched scales near preopercular angle, others along sides of top of head. Eyes large. Adipose eyelids obsolescent, not nearly covering one-third of eye posteriorly. Snout longer than eye. Nostrils closer together than to eye. Interorbital broad and flat. Jaws protrusible. Mandibulary angle very obtuse. Maxillary exposed and reaching beyond posterior slit-like nostrils. Upper jaw terminal. Upper lip not notably thick, toothless but with microscopic cilia, not papillose. A series of tooth-like bumps behind lower lip, which has a round symphysial knob. No transverse groove on lips. A groove before vomer. Tongue notched anteriorly. Free space along chin between opercles broadly open. Preorbital obscurely serrated. Opercular margin curving obliquely. Gill-rakers numerous.

Body rather deep, compressed, especially towards tail.

Rostro-dorsal profile rising acutely, rather humped before first dorsal fin.

Scales large, with minutely ciliated margins carrying on the sculpture of their surfaces, without clear edges; about six to eight basal radii. About 31 transverse series between head and hypural joint. Those on flanks present a hexagonal exposed surface. Most body scales have a thin central streak. Axillary scales at first dorsal and ventral fins but not developed at pectorals. Scales extend well over fins (except first dorsal and ventrals).

Origins of dorsal fins over about 10th and 20th body scales. First dorsal origin nearer snout than caudal base; spines thick and strong, the first



9. Ord River Mullet, *Moolgarda (Planiliza) ordensis,* Whitley. Holotype from Ord River. Also ventral aspect of head.

longest, reaching less than half its distance from the second dorsal fin, which is slightly higher than anal. Anal origin in advance of level of second dorsal origin, the fin with nine soft rays, last two with bases very close together. Pectoral much shorter than head, not reaching level of first dorsal spine, extending to eighth body scale, and with its base about middle of body. Caudal bi-lobed, weakly forked.

Colour (in formalin) grey above, lighter below. Scales on flanks with dark margins. Pectorals light in tone. Fins without marginal tones. Specimen stained green from copper in its container.

Described from a specimen 390 mm. (nearly 15½ inches) in total length. W.A. Mus. Regd. No. P.2758.

Locality.—Carlton Reach, Ivanhoe Station, Ord River, North-western Australia. Mr. C. F. H. Jenkins.

Differs from *Mugil compressus* Gunther (Cat. Fish. Brit. Mus., iii., 1861, pp. 416 and 451) in having depth one-fifth of total length, depth of caudal peduncle less than half head, interorbital much broader, in shape of interspace on chin, etc., and from other species in the key-characters given by Gunther and later authors, and incorporated in the above description.

ALDRICHETTA, *gen. nov.*

Orthotype, *Mugil forsteri* Cuvier and Valenciennes (Hist. Nat. Poiss., xi., 1836, p. 141. New Zealand. Ex *Mugil albula* Forster, Ms., not of Linné, Syst. Nat., ed. 12, i., 1766, p. 520, from America) = *Aldrichetta forsteri.*

Eyes yellow, not covered by adipose lids. Snout longer than eye in adults. Interorbital convex. Mandibulary angle obtuse or rounded; upper jaw terminal, overhanging lower. Upper lip not thick, papillose, or ciliated. Minute teeth on jaws, vomer, palatines and tongue, the latter having no keel. Free space along chin between opercles open, elongate-ovoid. Preorbital margin serrated. Opercular margin not as steep as in other genera. Gill-rakers long, slender and numerous. Rostro-dorsal profile very gently convex, the back straight. Depth about $3\frac{3}{4}$ to $4\frac{3}{4}$ in standard length. Scales in about 45 or more transverse series between head and hypural joint. Nearly 30 predorsal scales. Anal origin before level of origin of second dorsal. Anal fin with 12 soft rays, second dorsal with 10. Pectorals pointed, shorter than head. Axillary scales not developed. Depth of caudal peduncle less than half head.

This is the yellow-eyed mullet of Australia and New Zealand ("pilchard" of Western Australia) which is usually placed in the genus *Agonostomus* Bennett (Proc. Zool. Soc., London, xiv., March, 1832, p. 166), but the type of that genus is *A. telfairii* Bennett, from Mauritius, which has eight dorsal and nine anal rays, and many other differences (see Gunther's Catalogue, iii., 1861, p. 462).

I name the Australasian genus in honour of Mr. Fred. C. Aldrich, who served for many years as a Fisheries Inspector in New South Wales and became Chief Inspector of Fisheries and Game in Perth, Western Australia, from 1911 to 1937, an able and enthusiastic fisheries investigator.

A young Western Australian specimen is described and figured hereunder.

ALDRICHETTA FORSTERI (Cuv. & Val.).

(Fig. 10.)

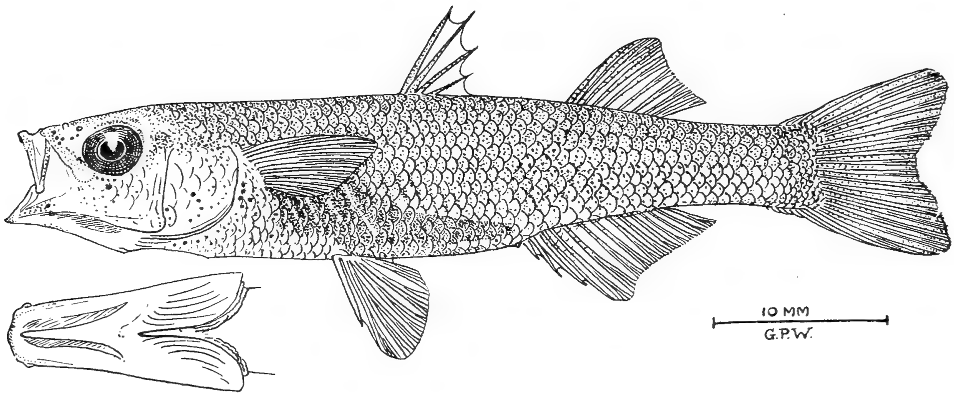
Br. 7; D.iv./i., 9; A.iii., 12. Sc. 40 plus. Tr. 14 or 15.

Head (12 mm.) 3.7, depth (9.5) 4.7 in standard length (45). Eye (3) 4, snout (2) 6; interorbital (nearly 4) and depth of caudal peduncle (4.3) about one-third head. Length to caudal fork, 52 mm.

Mouth terminal. Upper lip not very thick and not papillate. Premaxillary processes shorter than eye. Maxilla reaching to below anterior part of eye. Minute villiform teeth in jaws. Mandible truncately rounded anteriorly. No adipose eyelids. Snout short. Preorbital serrated. Cheeks and opercles with large scales, in 2 to 3 rows on cheeks. Nostrils large. Gill openings wide, membranes united across narrow isthmus. Gill-rakers slender, spaced, some longer than gill-fringes, about 20 on lower half of first branchial arch. Pseudobranchiae present.

Body compressed, deep anteriorly. Rostro-dorsal profile slightly convex over head, straighter along back. Body covered with deciduous cycloid scales, without differentiated margins (at least, at this stage) and four basal striae. More than forty transverse series of scales. About twenty predorsal scales (some missing in specimen). Ventral profile convex.

Origins of dorsal fins corresponding to about 14th and 26th body scales. First dorsal spine (6 mm.) reaching more than half its distance from first dorsal ray. First dorsal origin nearer snout than root of tail. Scales extend on to soft dorsal and anal fins. Anterior half of anal before level of soft dorsal. Nine dorsal and twelve anal rays. Pectoral base not entirely above



10. Yellow-eye Mullet, *Aldrichetta forsteri* (Cuv. & Val.). Young specimen from Bunbury.

middle of body, its tip not reaching to below first dorsal. Anal origin nearer first dorsal and ventral origins than to hypural joint. Axillary scale to ventral fin and an overhanging scale (which may develop into an axillary scale?) over pectoral base. Pectoral (8 mm.) much shorter than head. Caudal forked, lower lobe the longer.

General colour olivaceous, from brownish-grey on back to yellowish on sides, with the viscera bluish. Head, body, and fins densely infuscated with brownish chromatophores with black nuclei. Chin and lips speckled. Lower parts of gills plain. Eye bluish. No dark mark at pectoral base; pectorals whitish with infuscated tips.

Described from a specimen 45 mm. in standard length or about 55 mm., or 2-1/5th inches, in total length.

W.A. Museum Reg. No. P.2690, the largest of three, 37 to 45 mm. in standard length (P.2691-2).

Locality.—Bunbury estuary, Western Australia; 7th December, 1943; collected by Dr. D. L. Serventy.

Family Lutjanidae.

Caesioscorpis, *gen. nov.*

Orthotype, *Caesioscorpis theagenes,* sp. nov.

A new squamipinnate genus with the following distinguishing combination of characters:—

Head acutely pointed, compressed, tapering ventrally, scaly except for tip of snout and chin. Eyes large, lateral. Interorbital convex, scaly. Pre-

orbital entire. Maxillary thin, truncate. Lower jaw terminal, mandibular rami elevated and extensive. Small teeth in jaws, apparently none on palate. Nostrils rounded. No barbels. Operculum with two small flat spines. Preoperculum thin, venulose, crenulated at edge. Gill-membranes united by small membrane across narrow isthmus.

Body lenticular, compressed. Scales of moderate size, ciliated, imbricate, adherent, thin. Lateral line complete, tubes straight. Vent little before anal fin, no papilla.

Dorsal with eleven heteracanth spines, anal with three. Spines and rays compactly united by membranes. Soft dorsal and anal fins with plus or minus twenty rays, covered by scales. Fins not falcate or with produced lobes. Pectorals shorter than head with lower rays branched. Ventrals behind level of pectoral base. Caudal forked. Coloration plain, mostly light green above and silvery below.

Probably nearest *Caesio* but without the elevated anterior dorsal spines of that genus.

CAESIOSCORPIS THEAGENES, *sp. nov.*

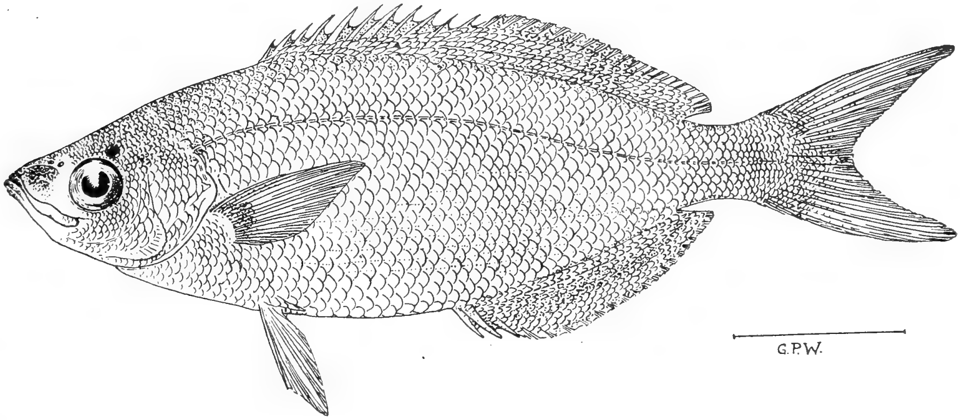
(Fig. 11.)

D.xi., 21; A.iii., 18; P.ii., 14; V.i., 5; C.16.

L. lat. 49 to hypural + 5 on tail. L. tr. about 9/1/19 (but some scales missing in type-specimen) to 4½/1/5 on caudal peduncle.

Head (30 mm.) 3.7, depth at middle of body (38) 3 in standard length (113). Eye (8.5) 3.5, snout (8) 3.7, interorbital (10) 3, pectoral (24) 1.2, and depth of caudal peduncle (11) 2.7 in head. Length to caudal fork, 126 mm.

General characters as defined for genus. Maxillary mostly sheathed by preorbital, reaching below eye. Scales evenly cover cleithrum, nape, and whole of body and extend over the fins. Middle spines of dorsal fin longest and longer than the rays.



11. Green Fusilier, *Caesioscorpis theagenes,* Whitley. Holotype from Blowholes, north of Carnarvon.

Colour in life pale greenish above and silvery below. After preservation, generally yellowish brown, brighter yellow on tail. Eye bluish. Snout dark brown. Fins with some grey infuscations. Pectoral axil grey.

Described and figured from the unique holotype, a specimen about 140 mm. (5½ inches) in total length. W.A. Mus. Regd. No. P.2795.

Locality.—In an oyster-surrounded rockpool near the blowholes, coastline about 30 miles north of Carnarvon, Western Australia. Coll. G. P. Whitley, 16th September, 1944, by firing .303 bullet into rockpool.

Family Sorosichthyidae, *nov.*

A new family of the Order Berycomorphi. Allied to Trachichthyidae, but with the spinous dorsal fin separate from the soft and consisting of ten spines instead of four (in *Trachichthys*) or up to seven in other genera. Only five soft rays in ventral fins; only two anal spines. No enlarged preopercular spine. No barbels. Scales large, ctenoid, less than thirty in lateral lines. Vent near bases of ventral fins.

One monotypic genus, from South-western Australia.

Sorosichthys, *gen. nov.*

Orthotype, *Sorosichthys ananassa,* sp. nov.

This small berycomorph fish from South-western Australia has five ventral rays, ten dorsal spines (the fourth longest), and less than thirty scales in lateral line. These characters alone clearly separate this fish generically from any other berycoid. For further details, see specific description. In facies and in form of dorsal fins, this fish rather recalls also the Holocenthridae, but the latter have more anal spines. It is perhaps closest to *Paratrachichthys* Waite, 1899, but is immediately separable by its fin and scale-counts, the scales being large as in Holocenthridae.

Gephyroberyx Boulenger, 1902, has a discrete spinous dorsal fin of eight spines, but has enlarged preopercular spine, vent near anal fin, smaller scales, and different formulae.

Sorosichthys ananassa, *sp. nov.*

(Fig. 12.)

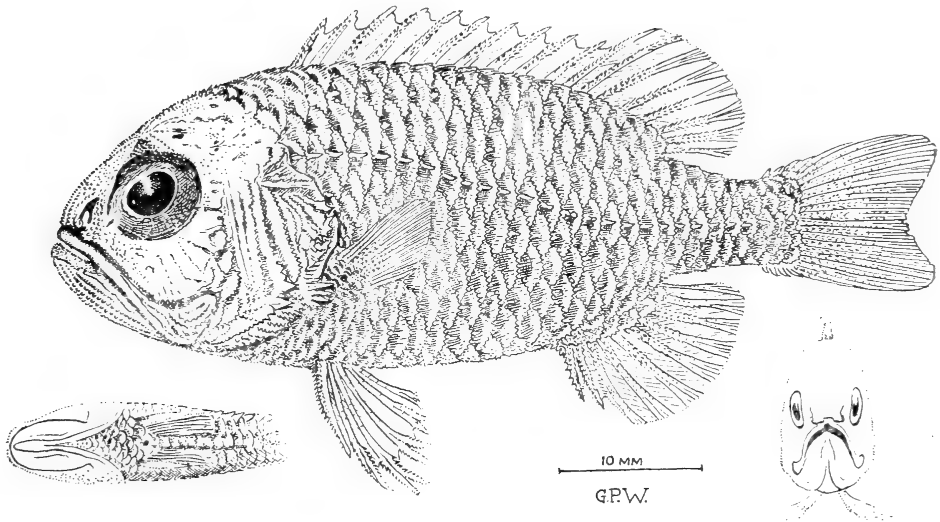
Br. 7. D.x., 8; A.ii., 8; P. 13; V.i., 5; C. 16 or 17. L. lat. left, 27; right, 24. Tr. 2/1/7.

Head (19 mm.) 2.7, depth (21) 2.4 in standard length (52). Eye (7) 2.7, snout (4) 4.7, least depth of caudal peduncle (5.4) 3.5 in head. Interorbital, 8; maxillary, 12; pectoral fin, 8; longest (fourth) dorsal spine, 6 mm.

Head large, bluntly rounded, exceedingly rugose on most of its surfaces and with numerous pores. Jaws subequal, a notch at either symphysis; no barbel; end of maxillary truncate. Mouth oblique, chin not very prominent. Bands of rough, villiform teeth in jaws. Apparently none on vomer. Nostrils large, without spines inside them. Eyes large, separated by a broad convex interorbital. A few scales on maxillary and cheeks. Suborbital shallow anteriorly. Preoperculum serrated, without very enlarged spine. Operculum with some rather irregular spines above and below and crossed

by several serrated subvertical ridges. Gill openings united across narrow isthmus. Gill-rakers slender, not numerous.

Body ovate, rather compressed; back rounded; belly flat with raised median ridge. Body covered with large, imbricate, very rugose, ctenoid scales. Abdominal scales not strongly keeled. Lateral line evenly curved, with simple tubes. Other scales on the body have similar tubes or a median



12. Little Pineapple Fish, *Sorosichthys ananassa*, Whitley. Holotype from off Bald Island. Lower left: breast and vent. Lower right: anterior aspect of head.

keel giving the appearance of several lateral lines. About 15 preventral scales and 12 abdominal scutes. About eight predorsal scales. Vent between bases of ventral fins. Raised scaly bases to soft dorsal and anal fins.

Dorsal originating over posterior portion of head, its spines united to one another and to soft fin by membranes. Base of spinous fin (18.3 mm.) much longer than that of soft fin (7). Rays longer than spines. Anal below and similar to soft dorsal, its base 8 mm., its spines small. Spines and rays denticulated. Pectorals and ventrals small and rounded. Caudal bilobed.

General colour, after long preservation, brownish, lighter on the raised portions of the scales, ridges on head, fin-spines, etc. Eyes bluish. Roof of mouth, gill-openings, and patches at ventral bases blackish. No striking colour-markings.

Described from the unique holotype, a specimen, 52 mm. in standard length or 2½ inches overall. W.A. Museum Regd. No. P.734.

Locality.—Trawled from between Bald Island and Haul Off Rock, about fifty miles east of Albany, South-western Australia; 28 to 32 fathoms; Government trawler "Penguin," 1920.

Suggested vernacular name: Little Pineapple Fish.

Family EPINEPHELIDAE.

EPINEPHELUS RANKINI, *sp. nov.*

Br. 7. D.xi., 16; A.iii., 8; P. 18. L. lat. c. 118 to hypural joint. L. tr. about 20/1/60, below first dorsal spines, to about 14/1/18 on caudal peduncle.

Head (102 mm.) 2.6, depth (93) 2.7 in standard length (265). Eye (15) 6.8, snout (25) 4.0 in head. Interorbital, 22.5 mm.; snout to end of maxilla, 50; depth of maxilla, 14; length of pectoral fin, 51.

No rugosities, bony ridges or mucous cavities on head. Head large, deep, mostly scaly behind about level of eye, though the anterior and cheek scales are minute and vestigial. Eyes remarkably small, interorbital broadly convex. Preopercular margin serrated, with several slightly enlarged serrae around its angle. Other serrae below suboperculum and at interoperculum. Opercular flap rounded, its upper border feebly curved. Three opercular spines, the uppermost most anterior, and further from the middle (most posterior) one than the latter is from the lowest spine. Lower jaw projecting strongly. Maxillary roundly truncate, its depth subequal to diameter of eye, naked, with small supplemental bone, only visible through dissection. Tongue spatulate, blunt anteriorly, smooth. Small cardiform teeth on jaws, vomer, and palate. Outer ones and a couple near front of upper jaw a little enlarged, and not depressible, but no canines; teeth are in about three rows along sides of mandibles. Nostrils circular, the anterior with skinny rim, but no flap or tentacle. Gill-rakers slender, flattened, internally spinulose, the longest (12 mm.) longer than gill-fringes but shorter than eye; there are 9/15 on first branchial arch.

Body robust, deepest at level of gill-flaps. Very small ctenoid scales cover the body and extend on to most of the fins and cover the back, breast and cleithrum where, however, they tend to become smaller or vestigial and merge into a leathery integument. The slightly ascending scale-rows cross the course of the lateral line which is normal in position, though along the caudal peduncle it is slightly nearer the dorsal than the ventral profile.

Base of spinous dorsal slightly longer than that of soft. Membranes of spinous fins with small pencils. First dorsal originating well forward, over opercular flap. The fourth spine is longest (38 mm.), longer than last spine (29) and subequal to longest dorsal ray. Third anal ray longest, more than half longest anal ray. Pectorals rounded, eighth ray longest. Ventrals behind pectoral base, the fin rounded, second ray longest, slightly shorter than pectoral, not nearly reaching vent. Caudal truncate.

General colour, in formalin, dark greyish-brown to chocolate on head, body and fins, becoming light in tone along chin and breast. Large, irregular cream spots occur asymmetrically over most of fish. No transverse bars on body or saddle-shaped blotch on tail. On the sides, the spots are mostly oval with the long axis vertical and nearly as long as eye; they are smaller on the breast and the isthmus is plain dirty greyish or cream. The spots are much smaller on the fins and are indistinct on the first dorsal and ventral fins. Unpaired soft fins with an extremely narrow cream border; inframarginally these fins also the ventrals are almost black. A grey smudge, but not a definite moustache-mark above maxilla. Eye bluish with dull pale yellow iris.

Described from the holotype of the species, a specimen 330 mm. or 13 inches overall.

Locality.—Netted off Onslow, Western Australia; Mr. F. J. Rankin, late 1944. W.A. Museum Regd. No. P.2847.

In comparison with all the numerous species of *Epinephelus,* it may be stressed that the small eyes, conspicuous spots, truncate caudal fin, ventral fins not reaching vent, and sixteen dorsal rays are diagnostic characters for those to whom a new species, however expertly described, is a *nomen nudum* unless compared with its congeners.

Named after Mr. F. J. Rankin, postmaster at Onslow, Western Australia, in appreciation of his valued specimens and notes of fishes from his district.

EPINEPHELUS SPIRAMEN, *sp. nov.*

D.xi., 17; A.iii., 8; P.17. L. lat. circa 68 to hypural joint (overlying about 48 tubes), plus some small scales on caudal base. L. tr. 9/1/36 at origin of first dorsal, to 8/1/10 on caudal peduncle.

Head (84 mm.) 3.1, depth (72) 3.6, pectoral (52) 5.0 in total length (263). Eye (18) 4.6, interorbital (12) 7 in head. Snout (16) less than eye.

Only vestigial scales on top of head; none on maxilla, which reaches below posterior half of eye and is truncately rounded. Opercular flap blunt.

Three opercular spines, the topmost anterior and the middle one largest and most posterior, and equidistant from the top and bottom ones. Preoperculum serrate, serrae slightly enlarged at angle. Nostrils oval, the anterior ones lipped. Supplemental bone united to maxillary by a low ridge; width of maxilla more than half eye-diameter.

Cardiform teeth on jaws, vomer, and palatines, some enlarged near symphyses and along sides. No very large canines.

Tongue long and spatulate, toothless. Gill-rakers 5 + 1 + 8 + 4 rudiments on first branchial arch, the middle raker enlarged, 6.5 mm. long.

All of body, back included, scaly. Lateral line normal.

All fin margins rounded. The third to fifth dorsal spines are longer than the others. Second anal spine (26 mm.) longer and stronger than third, but shorter than anal rays.

Life-colour mostly a rusty to brick red, the edge of each scale darker; ground-colour of head olive-greenish.

A white band across each side of lips; a white bar from behind maxilla to interopercle, continued on anterior part of breast but not meeting its fellow on the other side; two more oblique white bars before base of pectoral. Body crossed by six broad brick-red cross-bars descending slightly obliquely forwards. Two dark cross-bars on top of head. A large dark brown blotch behind eye. Eye olivaceous above and dull reddish-brown iris. Nostrils red. Inside of mouth white.

First dorsal fin mostly pale dirty-brownish with inframarginal brick-red stripe having an olivaceous blotch on membranes between each spine; distal pencils white. Other fins rusty-red with yellowish tinge distally and margined narrowly with milky white. Minute milky spots on membranes of ventral and anal fin, in pectoral axil, and where dorsal fins join the back.

Described from a female specimen, 263 mm. or 10½ inches in total length. W.A. Museum Regd. No. P.2796.

Locality.—Rocks near the blowholes, on coastline about 30 miles north of Carnarvon, Western Australia; handline, on kangaroo steak bait.

Similar in facies to the *Serranus stoliczkae* of Day's "Fishes of India," 1875, but that species has more numerous gill-rakers, maxilla reaching posterior border of eye, deeper body, different scale-counts, spots on head and shoulders, etc. From other species my novelty is separable by the key characters given by Boulenger (Cat. Fish. Brit. Mus.).

Family TERAPONTIDAE.

Genus MESOPRISTES Bleeker, 1845.

MESOPRISTES JENKINSI, *sp. nov.*

D.xiii., 12; A.iii., 8; P. 16. L. lat. 52 to hypural. L. tr. 8/1/17. Cheek scales in about 8 or 9 rows.

Head (42 mm.) 2.7, depth (45) 2.5 in standard length (116). Eye (9) 4.7 in head, shorter than snout (13) and interorbital (12). Fifth dorsal spine (15) subequal to fifth dorsal ray (15.5). Second anal ray, 19 mm.

General characters as in Ogilby and McCulloch's description of *argenteus* (Mem. Qld. Mus., v., 1916, p. 115). Preorbital not serrate, notched to received tumid lip.

Maxillary not entirely covered by lip. Interorbital and cranial ridges obsolete externally.

Lower opercular spine not greatly enlarged.

Nostrils well separated.

Supra-cleithrum exposed, denticulate. Longest dorsal spine (5th) longer than most of the rays. Second anal spine very strong, longer than 3rd, subequal to rays. Caudal emarginate.

Colour fairly uniform dark slate grey. No conspicuous markings and no dark spot on bases of scales.

Total length, 6 inches.

Described from the holotype in the W. Australian Museum. (No. P.2763.)

Locality.—Ivanhoe Station, Ord River, North-western Australia; collected by Mr. C. F. H. Jenkins, Government Entomologist of Western Australia.

Differs from *Mesopristes argenteus* (Cuv. & Val.) in dorsal fin formula and smaller dorsal spines, more pectoral rays, and in proportions. From other species in the key characters given by Ogilby and McCulloch (Mem. Qld. Mus., v., 1916, p. 101) and Fowler (Bull. U.S. Nat. Mus., 100, xi., 1931, p. 326). A doubtful Western Australian record of *"Sparus argenteus"* may refer to this species.

Family SCIAENIDAE.

SCIAENA ANTARCTICA REX, *subsp. nov.*

Similar to *S. antarctica* Castelnau, 1872, as described and figured by Ogilby (Mem. Qld. Mus., vi., 1918, p. 70, pl. xxi.), but with a smaller eye in relation to the head (of which it is about one-seventh) and with D.ix., i., 24 instead of 27 to 28 as in eastern Australia. The mouth extends behind eye. A.ii., 7; P.ii., 17; C. 15. Head, 238 mm.; depth, about 205; eye, 31; preorbital, 27; interorbital, 47; snout, 58; maxilla, 95; depth of caudal

peduncle, 63 mm. L. lat., 57 + 5. L. tr., 9/1/15. Total length, 990 mm. Weight, cleaned, 19 lb. Preoperculum as described by Castelnau. Tail with three or four rows of transverse spots; pectoral axil yellowish.

A second specimen, 900 mm. long, was 16½ lb. whole weight, a developing female, ova not visible Gill-rakers 4/8 to 9 as in *antarctica*.

Locality.—Onslow, Western Australia; November, 1944.

Corvina jubata Bleeker, 1855, from Borneo has 24 dorsal rays but differs largely in proportions.

Family HISTIOPTERIDAE.

Genus PARISTIOPTERUS, Bleeker, 1876.

PARISTIOPTERUS GALLIPAVO, Whitley.

Paristiopterus gallipavo Whitley, Proc. Roy. Zool. Soc. N.S. Wales, 1943-44, August 31, 1944, p. 28, fig. 4.

D.vii., 17; A.iii., 9; P.ii., 15; V.i., 5; C. 15 branched rays. L. lat. 82.

Head (169 mm.) and depth of body (165) about 3.5 in length to end of middle caudal rays (590). Eye (26) 6.5, orbit (35) 4.8, interorbital (42) 4.0, upper jaw (62) 2.7 in head. Snout, measured from orbit to anterior part of preorbital, 71 mm. Pectoral, 121; ventral spine, 98; second anal spine, 59; lower caudal lobe, 120; dorsal spines, 7, 11, 216, 232, 193, 190 and 168 mm. from bases to tips; first (longest) dorsal ray, 88. Depth of caudal peduncle, 38.

Upper profile concave before eyes, bulging over occiput; general form rather deep and compressed and slightly tapering posteriorly. Lips thick and rugose, the upper terminal. Maxilla not reaching level of nostrils and mostly sheathed below preorbital posteriorly. A bunch of large moveable canines at middle of each jaw followed by broad bands of large, round, blunt molars in up to 5 rows in upper and 2 (rarely 3) in lower jaw. No vomerine or palatine teeth. Angle of mouth nearer to vertical from eye than to end of snout. Nostrils large, oval, the posterior largest. Head scaleless, except for some beneath skin on cheeks. Interorbital rising to median crest, on each side of which are several short bony ridges and some rugosities. Other rugosities around eye, across preorbital, and some fine ridges on opercles. Eyes large, not filling orbit but surrounded by wide lids, situated in posterior half of head. Chin coriaceous; sides of head smooth. Preoperculum with rounded angle, almost straight posterior border and coarsely serrate edges. Operculum with round membraneous flap. No spines. Cleithrum and supracleithrum exposed, with many fine ridges, pectoral axil naked and smooth.

Body covered with rather large, round, thin cycloid scales, not arranged in regular rows. Lateral line with simple tubes. On the right side (but not the left) there are three tubes running along the side in advance of the median line from the caudal peduncle and below the ascending curve of the lateral line between the ends of the dorsal and anal fins, thus making a Y-shaped junction there, but this feature is doubtless abnormal. Dorsal and anal fins with scaly sheaths. No enlarged axillary scales.

Spinous dorsal fin preceded by a procumbent spine. The first and second dorsal spines are short but the remaining five are elongate, compressed and wavy, forming a crest, their lengths are given in the dimensions above. The base of the spinous dorsal fin (116 mm.) is shorter than that

of the soft portion (160). Anal fin with three spines, the first very small, the second very long, compressed and strong, the third smaller than the second; first two anal rays considerably longer than the others. Pectorals long and rather pointed. Ventrals similar in shape to pectorals but longer (125 mm.) and with a large, strongly compressed spine. Caudal forked, the upper lobe the longer; median rays, 50 mm. long.

General colour when fresh, pearly-greyish, becoming darker or suffused with pinkish on head and along back where there are numerous conspicuous round brownish spots up to about 4 mm. in diameter. Eyes and fins greyish.

Described from the unique holotype of the species, a specimen 630 mm. or just over two feet in total length. It has, unfortunately, been gutted, so details as to gill-rakers, viscera, sex, etc., cannot be given.

Locality.—Found floating dead off Rockingham, Western Australia, on February 23, 1944. W. Aust. Museum Regd. No. P.2589.

Distinguished from all other boarfishes by the following combination of characters: (1) Base of spinous dorsal fin shorter than that of soft; (2) posterior dorsal spines elongated, and longer than the rays; (3) anal spines three. The last two characters especially distinguish this fish so markedly from the type of *Paristiopterus* (*labiosus*) that the new Western Australian species deserves subgeneric separation as *Glauertichthys,* subg. nov.

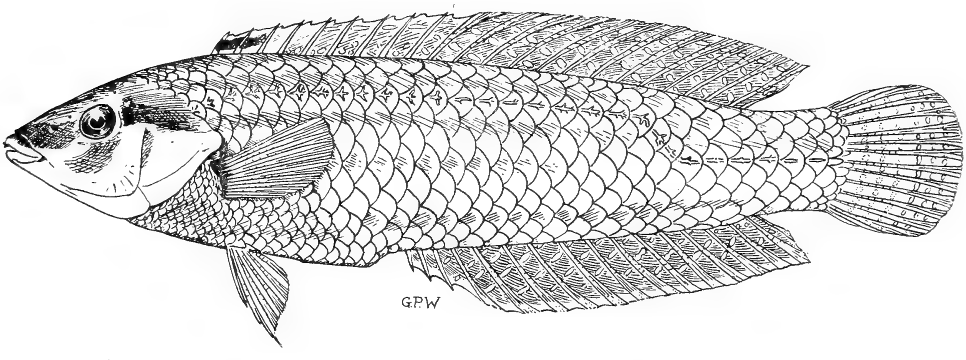
Family CORIDAE.

Genus CHOEROJULIS Gill, 1862.

CHOEROJULIS BROWNFIELDI, *sp. nov.*

(Fig. 13.)

D.ix., 14; A.iii., 14; P.ii., 11; C. 12. L. lat. 28. L. tr. 2/1/10 to 4/1/4 on caudal peduncle.



13. Wrasse, *Choerojulis brownfieldi,* Whitley. Holotype from Garden Island.

Head (34 mm.) 3.7, depth (33) 3.8 in standard length (125). Eye (6) 5.6, snout (10) 3.4, interorbital (8) 4.2 in head.

Head naked. Preoperculum entire. Lips fleshy, mouth not reaching as far as eye. Several separate, forwardly directed conic teeth in each jaw,

anterior ones largest, there being two canines in front of each jaw. Posterior canine present in upper jaw. Lateral teeth not coalesced; no cutting edges or flared-out teeth.

Form slender, very compressed. Scales cycloid with 26 basal radii and about forty apical striae. Thoracic scales smaller than those of body. Lateral line continuous, bent abruptly behind, each scale with a tube which usually breaks into three or four branches. Two rows of scales between lateral line and back.

Dorsal and anal fins without scaly sheaths. Dorsal spines increasing in height backwards, the anterior two not divergent or differentiated. Caudal fin not covered by scales.

General colour, after long preservation, brownish, with traces of three or four darker bars along body. A dark bar crosses snout and the post-orbital and suborbital regions are dusky. There is a dark blotch behind eye, another on first two dorsal membranes and along pectoral base. The unpaired fins are olive-brownish to greyish and ornamented with pearly-green spots as in figure; the anal has a light margin. No ocellus at caudal base.

Described and figured from the holotype, 125 mm. in standard length, or nearly six inches overall. W.A. Museum Regd. No. P.110.

Locality.—Garden Island, off Fremantle, Western Australia.

A smaller incomplete specimen from Mandurah, about 55 mm. in standard length, has a blackish ocellus on posterior part of soft dorsal fin.

Differs from other species in coloration and in the combination of characters given above, especially as regards fin-formulae and dentition.

Named after Mr. Edward John Brownfield, Acting Chief Inspector of Fisheries and Game, Perth.

At first, I thought this species might have been *Pseudojulis lineata* Castelnau, 1873, which has not been recognised since first described, but I now consider Castelnau's species to be a synonym of *Ophthalmolepis lineolatus cyanogramma* Richardson, 1850, a fairly common South-western Australian fish with which Castelnau's description agrees better in squamation, formulae, and dental characters.

Family BODIANIDAE.

Genus CHOERODON Bleeker, 1845.

CHOERODON PAYNEI, *sp. nov.*

(Fig. 14.)

Br. 6. D.xiii., 7; A.iii., 10; P.ii., 14; V.i., 5; C. 11 branched rays. L. lat. 29. L. tr. 3/1/9. Predorsal sc., 5; preventral, 8.

Head (104 mm.) 2.6, depth (114) 2.39 in standard length (273). Eye (16) 6.5, interorbital (24) 4.3 in head.

Head largely naked; about six rows of spaced, small, circular cheek-scales; other non-imbricate scales on operculum. Mouth reaching to below space between nostrils. Canines peg-like, not flared out or very curved; the middle two in upper jaw much larger than the outer two. In the lower jaw the outer two are larger than the inner and slope outwards. Behind the canines is a row of coalesced teeth along each side of each jaw. No

posterior canine. Lips normal. Tongue very small, rounded, plicate. Preoperculum entire. Gill-rakers short, tufted; 7 plus 9 on first branchial arch.

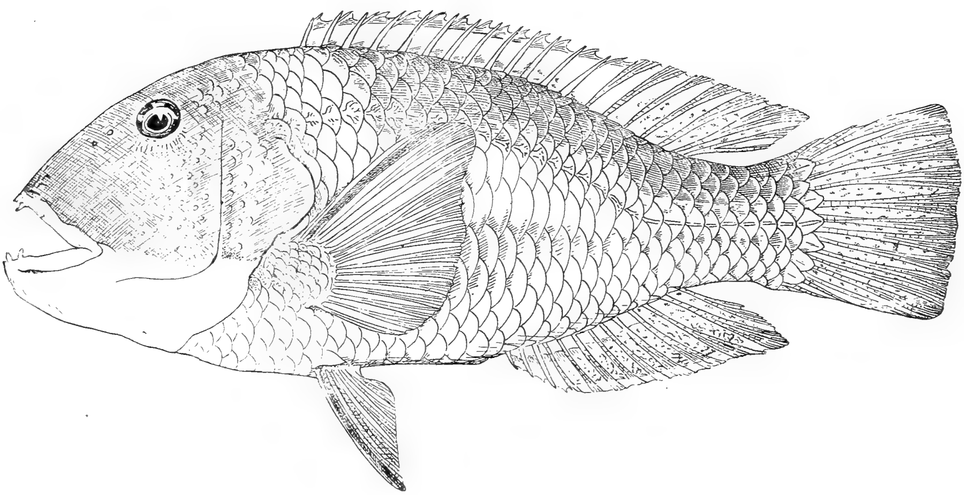
General habit of body and fins as usual in the genus and as illustrated here. No raised scaly bases to fins. Lateral line continuous, its tubes arborescent. Thoracic and precaudal scales normal. Ventral fins not reaching anal. Caudal margin convex.

General colour of the living fish pale apple-green. A broad pale rusty bronze bar along each side of posterior part of body. Iris peacock-blue with slight bronze spot at top and on each side (viz., at 12, 3 and 9 o'clock). A pale peach tinge below face. Several pale bluish bars in various directions near premaxillae, vanishing after death. Most of lips and teeth pale blue. A coppery bar along lower edge of lower lip. Inside of mouth white. Dorsal fins greyish, with a bright blue border and inframarginal band of coppery brown. Anal green proximally to greyish distally and crossed by recticulations of dull coppery. Caudal similar, but with greyish-blue margin and bright blue upper and lower tips. Pectorals green, peacock-blue towards tip and with coppery base. Ventrals mostly pale green, but the spine is blue, first ray coppery, and third bluish-green.

Described and figured from the holotype of the species, a specimen 273 mm. in standard length or nearly 13 inches overall.

Locality.—Off east coast of Dirk Hartog Island, Western Australia; handline, 25th August, 1944; coll. G. P. Whitley.

Smaller examples show some colour-variation. The rusty bronze bar along the posterior part of body may be broken up into several bands of the same colour. A light grey area may appear across the shoulders after death, but there are no light oval patches, black areas, or saddle-shaped blotches as in some other species of the genus.



14. Tuskfish, *Choerodon paynei,* Whitley. Holotype from Dirk Hartog Island. G.P.W. del.

This novelty is distinguished from its congeners mainly by its coloration, but also by its shape and proportions, as figured herewith. It is named in honour of Flight-Lieutenant George Herbert Payne, with whom I was associated in some experiments on sharks in Western Australia in 1944.

Family Limnichthyidae.

Limnichthys fasciatus major, *subsp. nov.*

Limnichthys fasciatus Waite, Rec. Austr. Mus., v., 1904, p. 178, pl. xxiii., fig. 4. Lord Howe Island.

This small rock-pool fish is known from Lord Howe Island, north of New Zealand, and New South Wales, where it grows to a length of less than two inches. In a collection of fishes made by Mr. W. B. Alexander at Garden Island, Western Australia, I was surprised to notice a specimen of this species 2-1/3rd inches long (W.A. Mus. Regd. No. P.121). This specimen greatly extends the known range of the genus and differs sufficiently from Waite's description to be regarded as the type of a new subspecies, for which I propose the name *major*.

D. 21. A. 24. L. lat. 41.

Head (12 mm.) 4.1, depth (6) 8.3 in standard length (50). Eye (2) 6 in head. Length of caudal subequal to depth of body. Eyes less than half a diameter apart. Otherwise as in typical *L. fasciatus*.

Family Blenniidae.

Genus Dasson Jordan and Hubbs, 1925.

Dasson Jordan & Hubbs, Mem. Carnegie Mus., x., 1925, p. 318. Orthotype, *Aspidontus trossulus* Jordan & Snyder, 1902. *Id.*, Norman, Ann. Mag. Nat. Hist. (11), x., 1943, p. 806.

Ostreoblennius Whitley, Mem. Qld. Mus., x., 1930, p. 20. Orthotype, *Petroscirtes (O.) steadi* Whitley, 1930.

Dasson duperreyi, *sp. nov.*

D.iii., viii., 20 = 31; A.ii., 20; P. 14; V. 2; C. 11.

Head (24 mm.) 3.7, depth (18.5) 4.8 in standard length (89) measured to hypural joint. Eye (6) 4, and interorbital (7) 3.4 in head. Snout, 7.25; gill-opening, 3.25; pectoral, 14; depth of caudal peduncle, 9; and length to end of middle caudal rays, 110 mm.

Snout blunt, anterior margin of lower jaw almost straight; upper profile of head convex. Mouth reaching to below eyes. Lips without folds, the upper overlapping the lower laterally. A slightly curved row of moveable incisor teeth anteriorly, flanked by enlarged canines, one on each side, much larger in lower than in upper jaw. Eyes large, their diameter less than the width of the almost flat interorbital. No crest or flap on top of head. A small mental cirrhus on each side and a small tentacle over the hinder part of each eye; a minute cirrhus at nostril and a tiny flap at origin of lateral line. Gill-openings reduced to small orifices above level of pectorals. Pores around eye and preoperculum.

Head and trunk subequal to rest of body without caudal fin. Body smooth, compressed. Lateral line reduced to a few simple tubes ascending from over gill-opening to below dorsal rays and dipping slightly to end over level of vent. A minute papilla behind vent at origin of anal fin.

Fins not enveloped by skin. Dorsal and anal fins attached by membrane to caudal peduncle immediately in advance of roots of caudal rays. Dorsal originating over preopercle, the first three spines rather long, soft, and curved and with more extensive membranes than those following, but not separated as a distinct fin and none of them produced. The following eight spines are little shorter than the twenty rays posteriorly. Anal with two short soft spines and twenty rays. Pectorals short, rounded. Ventral spine obsolete, two functional rays, with trace of third fused to second. Caudal emarginate, with the longest rays a trifle produced.

General colour (in alcohol) dull brownish, becoming lighter or yellowish on lower part of head and body. Most of fins yellowish. Upper half of head and body with a broad dark brown transverse band from snout to root of tail; this is broken up on the body by V- or W-shaped light areas descending from the back in about eight or nine places. A dark blotch on caudal base. Throat and belly without markings. Five or six dark spots or oblique marks between angle of mouth and pectoral base. A dusky bar along lower lip and a small dusky crescent below each angle of mouth. Teeth, gill-opening, paired and caudal fins yellowish. Dorsal and anal fins with numerous irregular brown blotches on rays and membranes, particularly dusky and tending to form a continuation of the dark body-bars on the proximal half of the dorsal fin. A blackish tip to first dorsal spine. Eye dull blue.

Described from the holotype of the new species, a specimen, 89 mm. in standard length or 4.45 inches overall. W.A. Museum Regd. No. P.2152.

Locality.—Shark's Bay, Western Australia. Coll. John Gregory in 1940.

Paratypes: Several specimens in the W.A. Museum, Perth. One, 50 mm. long, has numerous round whitish spots on the sides, ten of these being enlarged and forming a row just below median line of body. D. 31; A. 22; V. 3. Regd. No. P.2153.

Other paratypes in the Australian Museum, Sydney (Regd. No. IB.323-5 and 347), collected by me from dredgings in Useless Inlet, Shark's Bay, 28th June and 6th July, 1939.

The species is named after ensign Louis Isidore Duperrey, one of the naturalists of the "Uranie" expedition, which visited Shark's Bay in 1818.

This novelty is distinguished from its congeners by its fin-counts, proportions, and coloration. The cephalic tentacles are also probably characteristic, though these are not always stressed in descriptions of allied species. From *Dasson variabilis* and *viperidens,* it is distinguished by having more than 30 dorsal spines and rays and by its colour-markings. The genotype, *D. trossulus,* has a light band along lower part of head and fewer anal rays. *Dasson duperreyi* is near *D. icelii* (Ogilby, 1894) from Lord Howe Island and *D. steadi* (Whitley, 1930) from eastern Australia, but lacks the produced dorsal spines and more slender bodies of those species. Working in Perth, I am unable to consult descriptions of some of the other species mentioned by Norman.

Genus Graviceps Fowler, 1903.

Graviceps Fowler, Proc. Acad. Nat. Sci. Philad., lv., 1903, p. 170. Orthotype, *Petroscirtes elegans* Steindachner, 1876, from Japan.

Graviceps alexanderi, *sp. nov.*

D.xiv., 19 = 33; A.ii., 25; P. 13; V. 2; C. 11 et lat brev.

Head (8.5 mm.) 3.6, depth (6) 5.1 in standard length (31).

Anterior profile bluff. Eyes large, their diameter (2.3 mm.) exceeding interorbital width, and snout. Nostrils with raised flaps. No crests or tentacles on head. Maxillary reaching below middle of eye. Upper lip with a fold posteriorly, lower lip with overhanging lateral flap. Anterior margin of lower jaw transversely rounded. Less than twenty, slightly moveable incisors in each jaw, flanked by a lateral canine larger and more interior in lower jaw. Pores around eye and preopercle. Gill-opening small, extending very little before pectoral base; gill-membranes broadly united with isthmus.

Body compressed, naked. Lateral line reduced to a few simple tubes anteriorly. A small papilla before first anal spine. Depth of caudal peduncle, 2.5 mm.

Dorsal fin not notched, the spines not differentiated. No produced spines or rays, or branched rays. Dorsal and anal fins united to caudal peduncle by membrane. Caudal free, rounded.

General colour (in alcohol) light yellowish-brown, conspicuously ornamented with darker, reddish to purplish-brown markings. On the body, these take the form of nine crossbands, most of which have, at the middle of the sides, an anterior and posterior dark bluish spot, separated by two myomeres; the middle of each crossband is lighter in tone than the rest and some of the bands continue on to the dorsal fin. There are not several rows of spots on the body posteriorly. Chin and throat crossed, or almost crossed, by four or five irregular purplish-brown bars which extend up to cheeks. Eye bluish, with a crescent-shaped blue spot a little behind it; a lighter and more diffuse blue mark behind gill-opening. Belly plain yellowish. Anterior part of pectoral base brown. The paired fins and the caudal are mostly yellowish, with slight infuscation. The dorsal and anal are irregularly blotched with rusty brown and the fin-ray tips are cream.

Described from the holotype of the species, a specimen nearly 1½ inches long, the smaller of two in the W.A. Museum, Perth (Regd. No. P.671).

Locality.—Fremantle, Western Australia; living in holes in the wharf piles, October, 1919; coll. by W. B. Alexander.

A larger paratype (No. P.398), caught on 10th November, 1913, at Sandy Island, Houtman's Abrolhos, is 2-3/10th inches long and has D.xiv., 21; A.ii., 25; a dusky blotch on middle of second dorsal fin.

Three specimens (perhaps the male of the species), from the Percy Sladen Expedition to the Abrolhos (W.A. Mus., P.395; collector's No. 7) are 42 to 49 mm. in standard length and show some colour-variation. The largest of them has general characters as in the typical *G. alexanderi,* described above, except for the following differences.

D. 34; A.ii., 23; P. 13; V. 2; C. 11 et lat. brev.

Head (10 mm.) 4.9, depth (8) 6.1 in standard length (49). Eye (3) slightly less than snout, but more than interorbital width (less than 2). Depth of caudal peduncle, 3.7 mm. Maxillary just reaching below posterior half of eye. Gill-openings entirely above level of pectoral base. Some of the caudal rays produced. Length of posterior dorsal fin-rays about equal to depth of body beneath them.

General colour (in alcohol) almost uniform dull olive brownish, without conspicuous spots or bands. Eye and belly blue. Fins mostly yellowish. Posterior portions of caudal dark brownish. (In the paratypes the dorsal has either a dark brownish blotch on posterior rays, or the distal halves of dorsal and anal fins are dusky.)

Five other specimens (P.396; Coll. No. 8) from flats on Wallaby Island, Abrolhos; Percy Sladen Expedition, show both types of colour-pattern. The largest is 3.3 inches long and its anterior few dorsal spines are very short.

Range.—Western Australia, from Fremantle to Abrolhos.

This beautiful little fish is named in honour of Mr. Wilfred Backhouse Alexander, M.A., now residing at Oxford, who is well-known for his work on Western Australian biology. The Abrolhos examples comprise the unidentified blennies mentioned in his report on the vertebrates of that region (Alexander, Journ. Linn. Soc. (London), Zool., xxxiv., 1922, p. 483).

The genotype of *Graviceps* Fowler, 1903, is the Japanese *Petroscirtes elegans* Steindachner, 1876, which has been described and figured by Jordan and Snyder (Proc. U.S. Nat. Mus., xxv., 1902, p. 453, fig. 6). That species and also several of De Vis' species of *"Salarias"* from Queensland differ from *Graviceps alexanderi* in fin-counts, coloration, and, to a less extent, in proportions.

Family Clinidae.

In one of his first scientific papers, McCulloch (Rec. Austr. Mus., vii., 1908, p. 36, pls. x.-xi.) gave an admirable review, beautifully illustrated, of such species as were available to him of the genera *Clinus, Petraites,* and *Cristiceps.* His paper has remained a sure basis for all later work on those blennies. A few slight modifications may now be made as the result of study of certain literature and specimens which were out of McCulloch's reach.

Several type-specimens seen by me in 1937 in the British Museum (Natural History) were labelled *Cristiceps robustus* Gunther, 1867, from Melbourne. These I determined as *Clinus perspicillatus* Cuv. & Val., 1836. I have also published elsewhere (Austr. Zool., 1941) that *Petraites fasciatus* (Macleay, 1881) = *P. nasutus* (Gunther, 1861).

Some other British Museum specimens labelled *Cristiceps argentatus* were not that species in Risso's sense and had been named *Cristiceps antinectes* by Gunther in 1861. These were Western Australian representatives of the Victorian *Petraites phillipi* (Lucas, 1891), which may thus have to be reduced to the synonymy of *Petraites antinectes* (Gunther). I select the largest Freycinet's Harbour specimen as lectotype of *antinectes* (No. 58, 12-27, 67). It was very like McCulloch's figure of *"phillipi"* but had rather more ocellated coloration; D. 3/29/4; A. 25; and depth 5 in standard length.

On looking through the series in the Western Australian Museum, Perth, I find Mr. Glauert has identified *Cristiceps aurantiacus* Castelnau,

from the North Mole, Fremantle (Regd. No. P.801), and Point Peron (P.1309 and 1706). New record for Western Australia.

McCulloch, in 1908, was apparently not aware that Richardson had described a species from King George's Sound: *Cristiceps axillaris* (Discov. in Austr. (Stokes), i., 1846, append., p. 486, pl. i., fig. 1). This is identical with *C. pallidus* Macleay, 1881, from the same locality, which McCulloch regarded as a synonym of *C. australis* Cuv. & Val., 1836.

Thus, we have the following synonymy for the Australian species, the last names being the correct ones, according to my determinations (for references, see Austr. Mus. Mem., v., 1929, pp. 348 *et seq.*):—

Cristiceps robustus, Gunther	=	Clinus perspicillatus (add S. Austr. to range).
		„ marmoratus.
		„ johnstoni.
		Petraites heptaeolus.
Petraites phillipi (Lucas)	=	„ antinectes.
		„ roseus.
		„ sellularius Whitley, 1931 (N.S.W. & Lord Howe Island).
Petraites fasciatus (Macleay)	=	„ nasutus (add Sth. Qld. to range).
Cristiceps axillaris, Richardson	=	Cristiceps australis.
		„ aurantiacus (add W. Austr. to range).
		„ argyropleura.
		„ tristis (add Victoria to range).
		„ multifenestratus.
		„ amaenus.
Petraites incertus, McCulloch	=	„ forsteri.
		Neoblennius fasciatus.

The status of some of the last-named species is open to question.

Family Milyeringidae, *nov.*

A new family of the Order Gobioidea to accommodate a new genus of blind cryptozoic gudgeons from fresh water in Western Australia. Separable from the Eleotridae by having no eyes, the ventral and first dorsal fins reduced in size. The naked head is criss-crossed by rows of sensory papillae; similar rows transverse the body anteriorly. Body covered with large, thin, adherent, cycloid scales, difficult to see and count; the breast is apparently naked anteriorly. Dorsal and anal fins free from caudal. Pectoral base not remarkably muscular.

Other characters as described below.

Perhaps evolved from some gudgeon similar to *Carassiops*, which is not known from Western Australia. However, the interesting implications of this new form must await fuller elaboration later when I can refer to more literature than is available to me here in Western Australia.

MILYERINGA, *gen. nov.*

Orthotype, *Milyeringa veritas,* sp. nov.

Head large, broad, and depressed; naked. Eyes obsolete. Body scaly. Rows of sensory papillae on head and trunk. Skin not notably loose or flabby. Mouth large, horseshoe-shaped. Bands of cardiform teeth in jaws, enlarged at sides of lower jaw. No barbels. No preopercular spine.

Typhleotris Petit, 1933, has six dorsal spines and eighteen anal rays, more numerous scales, and different head-characters.

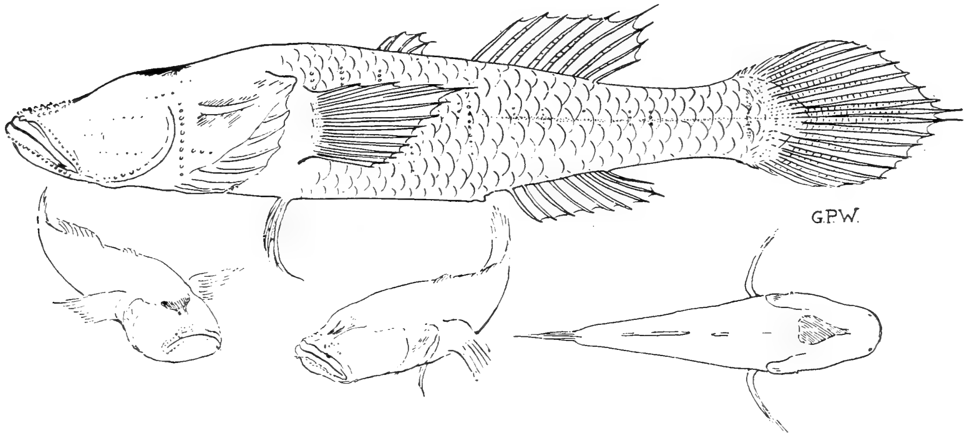
MILYERINGA VERITAS, *sp. nov.*

(Fig. 15.)

General characters as defined for family and genus, and facies as figured.

D.iv./9; A. 9; P. 13; V. 4; C. 17 et lat. brev. Sc. c. 26. Tr. 10. About 14 predorsal scales.

Head (17 mm.) 2.3, depth (8) 5 in standard length (40.5); depth of caudal peduncle (4) 4.2 in head. Upper profile of head concave over snout, bulging over preoperculum and rising to a humped shoulder. A flat



15. Blind Gudgeon, *Milyeringa veritas,* Whitley. Holotype from Milyering, North-west Cape, and attitudes of same when alive.

opercular spine. Lower jaw the longer, chin protruding. Tongue rounded, not notched. Anterior nostril tubular, over upper lip; posterior oval, larger. Sensory pores (tactile organs) around mouth, on top of snout and in rows crossing cheek, descending behind preoperculum, and on sides of trunk, but they are difficult to distinguish. Gill-openings wide, separated by the isthmus to which they are joined. Branchiostegal rays and membranes much exposed; there appear to be seven rays, but the lower ones are shrouded in folds of skin.

Body as wide as deep behind pectorals, but more compressed posteriorly. Vent and anal papilla conspicuous. A sulcus along middle of sides posteriorly. Rows of tactile sensory organs not bilaterally symmetrical.

Two dorsal fins, the first very reduced, with weak spines, the first two approximated. Anal small. Pectorals without free silk-like rays, though one or two upper rays are produced. Ventrals slender, separate. Caudal broadly rounded, with middle rays produced. Fin-rays simple, some articulated.

Colours in life.—Generally pale grey. A purplish stain on operculum over the gills. Top of head pale yellow with some purplish-pink on vertex. Posterior nostrils pink, looking like tiny red eyes in the albino head. A dark grey triangular mark, apex pointing forward, over brain. Fins flesh-coloured.

Described and figured from the holotype, 40.5 mm. in standard length or 50 mm. (2 inches) over all.

Locality.—Milyering, Yardie, 20 miles south-west of Vlamingh Head, North-west Cape, Western Australia, on Mr. Eric Payne's station, October 18, 1944. About a dozen specimens in freshwater well, bored through coral and limestone under a windmill. They sank to bottom when disturbed, but Mr. Payne caught the one described above. He says that there are sometimes three times as many in this well, but fish are not known to occur in any of the many other wells scattered over the peninsula. Fishes have been there at least sixteen years, to Mr. Payne's knowledge, but the well was sunk in the early 1920's, so they may have been there earlier; perhaps a subterranean river seeps through the limestone into the well. The fish are never pumped by the windmill into the adjacent tank. Their movements are slow and rather tadpole-like, the pectorals being stretched out sideways or pointing a little forwards and the ventrals held slightly forward like fingers. Perhaps they feed on the insects and other small animals which may drop into the water (ants, lizards and woodlice live under the boards covering the top of the well and keeping it dark).

Family GOBIIDAE.

DROMBUS HALEI LEPIDOTHORAX, *subsp. nov.*

Drombus halei Whitley, Rec. S. Austr. Mus., v., 1935, p. 353, figs. 4-5. Flinders Island, North Queensland. Holotype in S. Austr. Mus., Adelaide.

Seven specimens collected by Mr. John Gregory in October, 1938, from the beach near Denham, Western Australia, are referable to this species, which has not hitherto been recorded from Western Australia. They agree with the type-description but differ sufficiently to be named as subspecies, the discrepancies being:—

Type of *Drombus halei* in S. Aust. Mus., Adelaide.	Types of new subspecies in W.A. Mus., Perth. Nos. P.2667 to 2673.
Eye one-third of head.	Eye one-quarter of head.
Scales 28.	Scales more than 30.
Breast and lower pectoral base naked.	Breast and lower pectoral base scaly.
Head plain and dark; body without conspicuous white spots.	Head conspicuously white-spotted; other white spots on lower half of body.
Total length, $1\frac{1}{2}$ inches.	Total length about 2 inches.
Queensland.	Western Australia.

Family PLATYCEPHALIDAE.

PLANIPRORA MELSOMI, *sp. nov.*

A Western Australian Sand Flathead which I at first considered might be *P. mulleri* Klunzinger, 1879, but it differs in having more fin-rays and longer lower preopercular spine, etc.

D.ix./i., 13; A. 14. L. lat. 86 to hypural + 6 on tail.

Head (125 mm.) 3.2, depth (45) 9 in standard length (407). Eye (19.5) 6.4, interorbital (17) 7.3 in head. Snout to anterior margin of eye, 38 mm.

Head with smooth ridges above, but no spines, except a small one at each eye, supero-laterally. Lower preopercular spine slightly longer and thicker than upper. A broad flap of skin below preopercular spines on each side of head. Teeth villiform, none caniniform, but some slightly enlarged near symphysis and middle of upper jaw on jaws and palate. Tongue truncate. Gill-rakers 10 + 3 rudiments on lower half of anterior branchial arch. A spine at origin of lateral line. Eleven scales between origin of spinous dorsal and lateral line. Body and fins as in the family.

General colour in life, sandy-grey above, uniform white below. Upper surface of head with rusty brown spots, largest along sides; similar scattered small rusty brown spots and also some white spots on upper parts of body. Eye dark blue. Bronze to yellow iris with golden ring; upper parts of eye similar in colour to dorsal surface. Fin membranes hyaline. Spines and rays with alternating cream and brownish-grey markings, the latter tending to form round spots. Anal cream, or tinged pinkish. Caudal similar to paired fins, but with three or four round black spots along lower half of posterior margin, each spot surrounded by cream; a giraffe-like pattern of paler spots on rest of tail. Vent red.

Described from the holotype of the species, a developing female (stage 1), 470 mm. or 18½ inches in total length; head preserved in The Australian Museum, Sydney.

Locality.—Beach at Geraldton, Western Australia; 28th October, 1943. Ranges from Geraldton to Esperance.

Named in honour of Mr. Alf. K. Melsom, of the State Fisheries Department, Perth, in appreciation of his enthusiastic co-operation in fisheries work.

Family ALEUTERIDAE.

PERVAGOR MELANOCEPHALUS (Bleeker).

Monacanthus melanocephalus Bleeker, Nat. Tijdschr. Ned. Ind., v., 1853, p. 95. Solor, East Indies. *Id.*, Jordan & Seale, Bull. U.S. Bur. Fish., xxv., 1905 (1906), p. 365, fig. 69.

Pervagor melanocephalus Fraser-Brunner, Ann. Mag. Nat. Hist. (II), viii., 1941, p. 183.

First dorsal spine originating over anterior portion of eye; its anterior surface very rugose with upwardly directed spines superiorly and with a row of large lateral spines along its sides. A depression in the back to receive dorsal spine. A large, prickly, movable pelvic spine. Scales with a large central backwardly directed spine, sometimes two spines or smaller spine at side. Lateral line discernible. Origin of anal behind level of that of soft dorsal.

Colour in spirit: dark brown, gill-opening in a blackish bar, pelvic flap blackish; a chequered band at end of caudal fin.

One specimen, 96 mm. long, from the Abrolhos Islands; second Percy Sladen Trust Expedition, obtained by Professor W. J. Dakin, in 1915, constitutes a new record for Western Australia. The species has been recorded from New South Wales, Queensland, New Guinea, Samoa, and the East Indies.

Family OSTRACIIDAE.

Genus RHYNCHOSTRACION Fraser-Brunner, 1935.

RHYNCHOSTRACION NASUS (Bloch).

(Plate i.)

Ostracion nasus Bloch, Nat. ausl. Fische, i., 1785, p. 118, pl. cxxxviii. "Nile."
D. 9; A. 9; P. 10; C. 8 branched rays.

Eye (17 mm.) 1.6 in snout (28.5) or 1.8 in interorbital (32). Opening of carapace around mouth (19) 2.2, gill-slit (12) 3.5, pectoral (27) 1.5 in head (43), which is 3.1 in length of carapace measured from tip of snout to middle of lateral concavity before tail (137). Depth (60) 3.6 in total length (217), more than width of back (45). Anal or dorsal base (10) 4.3, length of caudal peduncle (39) 1.1, height of dorsal (29) 1.4 in head.

Tips of snout a small conic protruberance. Upper profile sloping up to the concave interorbital and overhanging supraorbitals. No spines over eyes or on body ridges. Gill-opening behind level of eye. Carapace five-angled. A median ridge along back, from behind head to before dorsal fin, is tubercular posteriorly. Dorso-lateral ridges extend from eye, swell and become tubercular over sides, converge on each side of dorsal fin and form an arrowhead-shaped closure behind that fin, the posterior point being tubercular.

The ventro-lateral ridges extend from the mouth backwards like the dorso-lateral ones and the carapace is similarly closed behind anal fin. Opening of carapace surrounding mouth pyriform, extending forward below snout. Brown, peg-like teeth in jaws. Nostrils in oblique groove before eye. About ten scutes between gill-opening and tail, about five between eye and snout, six along dorsal ridge, six down sides of body between ridges and about sixteen along belly. Scutes mostly granular. Caudal peduncle compressed, longer than snout, subequal to length of caudal fin.

Dorsal higher than anal, both their angles rounded. Anterior pectoral rays much longer than posterior. Caudal subtruncate; a simple ray above and below the branched ones.

Colour of dry specimens yellowish-brown, the fins lighter. Most of the fish (except upper part of flanks, dorsal, pectoral, and anal fins, and belly) with large dark brown spots, some about half eye-diameter.

Described and figured from a dried specimen in the Western Australian Museum, Perth (Regd. No. P.1852), 217 mm. or 8½ inches long. As it has been gutted, the number of belly-scutes was computed from two smaller specimens, of which one has a carapace of 46 mm. or is 70 mm. in total length, and the larger is incomplete, with a carapace of 172 mm.; the latter specimen would probably have measured at least 10 inches overall, but the tail is broken off.

Localities.—Shark's Bay, Wallal, and Broome, Western Australia. Other specimens from Cape Cleveland, Queensland, in the Queensland Museum, Brisbane, and the Australian Museum, Sydney.

New record for Australia.

NEW RECORDS OF WESTRALIAN FISHES.

In addition to the new species and records mentioned above and in my 1944 papers, the species listed below may now be added to the Western Australian fauna which, at the time of writing (December, 1944), including novelties, has 680 different species of fishes, excluding introduced ones. Doubtless many more new records and even new species will be discovered in the near future.

Most of these new records are based on specimens discovered by Mr. L. Glauert, Curator of the Western Australian Museum, and exhibited by him before the Royal Society of Western Australia. However, no notice of these novelties has hitherto been printed, and I am indebted to Mr. Glauert for so generously making his specimens and manuscripts available to me for the present purpose. Other fishes new to the fauna of Western Australia have been collected in the field or from the markets by myself during investigations for the C.S.I.R. Division of Fisheries, or identified for the first time from the collections of the Western Australian Museum. The registered numbers of W.A. Museum specimens are preceded by the letter "P" in this list; those of the Australian Museum, Sydney, by the letters "IB." To save space the names of classifactory groups (orders, families, subfamilies, etc.) have been omitted. These may be found in Whitley's "Fishes of Australia," Volume I., or in McCulloch's Check-list of the Fishes recorded from Australian waters (Austr. Mus. Mem., v., 1929-1930), the scheme of classification in those works being followed here. References to genera are mostly available from Neaves' "Nomenclator Zoologicus" and to species from McCulloch's work cited above, or from recent volumes of the "Zoological Record."

Orectolobus ornatus halei, Whitley. Augusta and Pelsart Id. (self).
Eucrossorhinus ogilbyi (Regan). Balla Balla (W.A. Mus. No. P.1234).
Carcharhinus mackiei (Phillipps). South and South-west Australia.
Isuropsis mako (Whitley). South-west Australia to Carnarvon.
Carcharodon albimors, Whitley. Fremantle to Carnarvon.
Carcharias arenarius, Ogilby. Bunbury to Jurien Bay.
Rhynchobatus djeddensis australiae, Whitley. Fremantle (P.1520 and 1719) and Shark's Bay (self).
Pristis zijsron, Bleeker. Carnarvon and Shark's Bay.
Pristis clavata, Garman. Billabong, near Derby (P.1300).
Urogymnus asperrimus (Bloch & Schneider). Broome (11,276, W.A. Mus.).
Bathytoshia brevicaudata (Hutton). Augusta, Fremantle, Geraldton.
Bathytoshia thetidis (Waite). Esperance and Bunbury.
Rhenoptera, sp. Carnarvon.
Chirocentrus vorax (Castelnau). Broome (P.558).
Nematalosa, sp. Noonkanbah.
Pisoodonophis cancrivorus (Richardson). Broome (P.549).
Muraenichthys breviceps, Gunther. Albany.

Verdithorax prasinus (Richardson). South-west Australia (W.A. Mus. 11,317).

Strongylura strongylura (van Hasselt). North-west Australia.

Athlennes caeruleofasciatus (Stead). Carnac Island.

Scomberesox forsteri, Cuv. & Val. Rottnest Island and Albany (P.757, 1905).

Arrhamphus sclerolepis, Gunther. North-west Australia.

Farhians commersonii (Cuvier). Whitford's Beach (P.257 2-3).

Lotella callarias, Gunther. Busselton.

Paratrachichthys traillii, Hutton. South-west Australia.

Holocenthrus diadema (Lacepede). Mandurah.

Lampris regius (Bonnaterre). Western Australia.

Iso rhothophilus (Ogilby). Albany.

Oedalechilus kesteveni, Whitley. Shark's Bay (P.325).

Polynemus plebeius, Broussonet. Shark's Bay and Exmouth Gulf (P.2780).

Plectropomus maculatus (Bloch). King Sound (P.629) and Shark's Bay (self).

Epinephelus merra, Bloch. Carnarvon and Cape Cuvier.

Epinephelus (Homalogrystes) tauvina (Bonnaterre). Peron Peninsula and Point Cloates (self).

Promicrops lanceolatus (Bloch). North-west Australia to Rottnest Island (P.2743).

Variola louti (Bonnaterre). "Perth Fish Markets, October, 1940" (P.2325).

Callanthias allporti, Gunther. Off southern coastline.

Pristiapogon victoriae (Gunther). Shark's Bay and Cape Cuvier.

Scomberoides lysan (Bonnaterre). Shark's Bay, Exmouth Gulf, Onslow.

Caranx ignobilis (Bonnaterre). Port Hedland and Shark's Bay.

Caranx ferdau paraspistes, Richardson. Off Fremantle.

Selar malam (Bleeker). Exmouth Gulf (P.2499).

Trachinotus ovatus (Linne). Peron Peninsula and Exmouth Gulf.

Diacope sebae (Cuvier). North-west Australia.

Parequula melbournensis (Castelnau). South and south-west coasts up to Bunbury.

Lethrinus perselectus, Whitley. Abrolhos.

Argyrops spinifer (Bonnaterre). Shark's Bay (P.659).

Monodactylus argenteus (Linne). Bay of Rest and Port Hedland.

Desmoprenes tetracanthus (Lacepede). North-west Australia.

Paristiopterus labiosus (Gunther). Southern coasts.

Goniistius vizonarius (Saville-Kent). Albany (W.A. Mus. 12905).

Neothunnus macropterus (Temminck & Schlegel). Geraldton (D. L. Serventy, MS.).

Germo germon steadi, Whitley. Quindalup.

Sarda orientalis serventyi, subsp. nov. Albany (P.3512, holotype) and Busselton (P.2568, paratype). Differs from *Pelamys orientalis* Temminck & Schlegel, Faun. Japon., pl. lii., in having about seven stripes instead of nine, lower spinous dorsal, maxillary reaching further back, larger size, narrower preopercular arc, and the finlets are not grey.

Xiphias gladius, Linne. Geraldton (P.1298).

Lepturacanthus savala (Cuvier). Derby.

Amphacanthus nebulosus (Quoy & Gaimard). Woodman's Point (P.1383), Geraldton, and Onslow.

Naso, sp. Point Cloates.

Pseudorhombus jenynsii var. *anomalus*, Ogilby. Shark's Bay (P.2169).

Ammotretis elongatus, McCulloch. Garden Island (P.124).

Synaptura nigra (Macleay). Onslow (P.2828).

Chromis scotochilopterus, Fowler. Southern Abrolhos and Dirk Hartog Island (P.2789, 2816, 2817).

Cheilinus (Thalliurus) chlorurus (Bloch). Blowholes, north of Carnarvon (P.2797).

Verreo oxycephalus (Bleeker). Abrolhos (P.389).

Parapercis haackei (Steindachner). Albany, Dongarra.

Crapatalus arenarius, McCulloch. North Beach and Garden Island (P.236).

Ichthyscopus sannio, Whitley. South-west Australia.

Foetorepus papilio (Gunther). Cottesloe (P.888 and 1050).

Repomucenus, sp. nov. Shark's Bay (Austr. Mus. Nos. IB.326, 358).

Salarias spaldingi, Macleay. Port Hedland (P.198, 578).

Istiblennius lineatus (Cuv. & Val.). Point Cloates (self, P.2810-12).

Pictiblennius tasmanianus (Richardson). Fremantle to Shark's Bay.

Pauloscirtes obliquus (Garman). Denham (P.2657-66).

Cristiceps aurantiacus, Castelnau. Fremantle (P.801) and Point Peron (P.1309, 1706).

Genypterus blacodes (Bloch & Schneider). Busselton (P.1974).

Butis amboinensis (Bleeker). Port Hedland (5803, W.A. Mus.).

Glossogobius giuris (Ham. Buch.). Noonkanbah.

Paratrigla papilio (Cuv. & Val.). Off Bald Island (P.730).

Dactyloptena orientalis (Cuv. & Val.). Geraldton (P.1417).

Gnathanacanthus goetzeei, Bleeker. Torbay (P.2355).

Neopataecus waterhousii (Castelnau). North Beach and Fremantle (P.805 and P.1302).

Thysanophrys cirronasus (Richardson). City Beach.

Suggrundus parilis (McCulloch). Shark's Bay and Onslow.

Rhycherus filamentosus (Castelnau). Cottesloe (P.810 and 2315).

Pervagor melanocephalus (Bleeker). Abrolhos (P.388).

Eubalichthys mosaicus (Ramsay & Ogilby). Albany and Rottnest Island (P.689).

Acanthaluteres guntheri (Macleay). Albany (P.2455).

Aracana ornata (Gray). Esperance.

Spheroides pleurogramma (Regan). Esperance to Denham.

Ovoides immaculatus (Bloch & Schneider). Onslow and King Sound (P.617).

Mola ramsayi (Giglioli). Fremantle, Rottnest Island and Rockingham.

LEICHHARDT'S SAWFISH.

By G. P. Whitley.

"Brown . . . told me that he had seen a very large and most curious fish dead, and at the water's edge. Messrs. Gilbert and Calvert went to fetch it, and I was greatly surprised to find it a sawfish (Pristis), which I thought lived exclusively in salt water. It was between three and four feet in length, and only recently, perhaps a few days, dead. It had very probably come up the river during a flood, for the water hole in which the creature had been detained, had no connection with the tiny stream, which hardly resisted the absorbing power of the sands. Another question was, what could have been the cause of its death? as the water seemed well tenanted with small fish. We supposed that it had pursued its prey into shallow water, and had leaped on the dry land, in its efforts to regain the deep water."

So wrote the explorer, Dr. Ludwig Leichhardt, in his "Journal of an Overland Expedition in Australia, from Moreton Bay to Port Essington" (1847, p. 288), on June 10th, 1845, when he was at the Lynd River, in what is now Queensland. His great interest in the dead animal was explicable; he was seeking a route to Port Essington, and any clue to a large river flowing westward to the sea might well be an indication in the right direction.

Through the courtesy of Mr. A. H. Chisholm, F.R.Z.S., I have been favoured with a contemporary extract from the manuscript diary of Leichhardt's companion, John Gilbert, bearing on the same discovery. On June 10th, 1845, at "Swordfish Camp," on the Lynd River, Gilbert noted:—

"We camped in the bed of the river beside a large and deep pool of water. Here we were tempted to try our lines, and, although not successful enough in catching fish for an edible purpose, yet we were enabled to enrich our collection with the addition of 5 and perhaps 6 species not before observed. But by far the most interesting circumstance of the day was the appearance of a Swordfish Shark, an ocean fish. We were, I believe, as much astonished at the sight of this creature as is related of Robinson Crusoe when he saw the impression of a man's foot in the sand, but perhaps our surprise was of a more agreeable nature, for it is the first positive indication of our approaching the coast. The fish was stranded and had apparently been dead only two or three days; but how it could have got up thus far in fresh water is a singular circumstance. That is to say, if the Dr.'s observations are correct we are at least 100 miles from the nearest coast, and the presence of this fish so far would go a great way to prove to us that the fall of the land from this must either be very slight or very gradual for the whole distance. At all events it puts us all on the qui vive. The Doctor for some time past has been in one of his usual gloomy fits and is very sparing in his ideas or information on general subjects. What he concludes from this incident he therefore keeps to himself. It is certainly very much to be regretted that we have such a leader, who never of late appears at all disposed to be cheerful or even agreeably civil to his companions."

Chisholm ("Strange New World," 1941, p. 251) quotes portion of this entry and adds:—

"Every 'Crusoe' in the party crowded round to examine the fish when Gilbert and Calvert brought it to the camp. Leichhardt (as noted in his book) was greatly surprised by the presence of the specimen, and he wondered how it came to be so far upstream and what had caused its death. But whatever deductions he made were not confided to his companions, for at this stage he was in a very morose mood and, as Gilbert complained, was 'keeping his conclusions to himself.'

"Gilbert himself was frankly puzzled. According to Leichhardt's estimates the party was at least one hundred miles from the nearest coast; the flow of water in the river was merely slight, and yet here was this large oceanic fish (it was three to four feet in length) which had been dead only two or three days. Possibly it had

found a way upstream in flood waters and, becoming stranded in a pool, had lived there for a considerable time.

" 'At all events,' Gilbert adds, 'the discovery puts us all on the qui vive.'

"It was in truth a remarkable circumstance to find an oceanic fish at such a point, for, as the party was to learn within a week, the spot was rather more than fifty miles from the mouth of the Lynd, and that mouth was merely a junction with another river."

A century ago, it was not known, as it is now, that there are some exclusively freshwater species of sawfishes in the rivers of tropical Australia, the East Indies, Burma, and other places, so that Leichhardt cannot be blamed for any faulty deduction. Indeed, I marvel at his extensive knowledge of ichthyology which enabled him to classify so accurately the Burramundi of the Dawson River and the Sawfish of the Lynd.

When I wrote the first volume of my "Fishes of Australia" I was aware that there were sawfishes in the freshwater rivers of Queensland, Northern and Western Australia, because of the records of Leichhardt, Macdonell (Abstr. Proc. Linn. Soc. N.S. Wales, June 29, 1887, p. vii.), and Dahl ("In Savage Australia," 1926, p. 137), but I had no specimens, so could not identify the species. Recently, I noticed in the Western Australian Museum, Perth, a sawfish from a billabong near Derby, W.A., which I determined as *Pristis clavata* Garman. Then, this year, Sergeant Bruce Shipway, who had been surveying in little-known parts of Queensland and Western Australia with the Australian Imperial Forces, gave me a photograph of a sawfish which he had obtained from the Lynd River in October, 1944, where specimens had been speared in freshwater billabongs. The species attained a length of five feet and had been seen in the Walsh, Mitchell and Palmer Rivers. He observed that the position of the first dorsal fin was different from those illustrated in my "Fishes of Australia." I am much obliged to Sergeant Shipway for his interest as, from his re-discovery of "Leichhardt's Sawfish," just a century after Leichhardt's announcement, it is possible to classify the species, which is obviously a permanent resident of the rivers and not a fortuitous visitor. The rivers flowing into the Gulf of Carpentaria and those of the southern shores of New Guinea support similar faunas, already named the Leichhardtian Fluvifaunula (see Iredale and Whitley, "South Australian Naturalist," xviii., 1938, No. 4, p. 64), and it is possible that freshwater sawfishes may yet be discovered in Papua. In further tribute to the explorer-naturalist, I propose for the Lynd River species the new name *Pristiopsis leichhardti*, the bibliography and definition of which are as follows:—

Family PRISTIDAE.

Genus PRISTIOPSIS, Fowler, 1905.

Pristiopsis Fowler, Proc. Acad. Nat. Sci. Philad., lvii., August 14, 1905, p. 459. Orthotype, *Pristis perrotteti* Muller & Henle, 1841. Generic name preoccupies *Pristiopsis* Schmidt, Entom. Zeitung. Stettin., lxvi., heft 2, November, 1905, p. 332, a genus of Insects.

Freshwater sawfishes which differ from *Pristis* Linck, 1790, or Latham, 1794 (type, *Squalus pristis* Linné, 1758, from Europe) in having fewer rostral teeth, a distinct lower caudal lobe, and with the first dorsal fin originating well in advance of the ventrals.

PRISTIOPSIS LEICHHARDTI, *sp. nov.*

(Fig. 1.)

Pristis Leichhardt, "Australian" (Sydney), March 26, 1846, supplement, and "Herald," same day; reprinted in Journn. Roy. Geogr. Soc., London, xvi.,

1846, p. 223, and Tas. Journ. Nat. Sci., iii., 1849, pp. 31 or 81 and 105. *Id.* Leichhardt, Journ. Overland Exped., 1847, p. 288 (Lynd River).

Fig. 1.

? *Pristis* Macdonell, Abstr. Proc. Linn. Soc. N.S. Wales, June 29, 1887, p. vii.; Proc. (2), ii., August, 1887, p. 412 (W. Austr.—freshwater). *Id.* Dahl, "In Savage Australia," 1926, p. 137 (Uniya Mission, N.W. Australia).

"Swordfish Shark," Chisholm, Strange New World, 1941, pp. 251, 252. *Ex* John Gilbert's MS. diary, June 10, 1845, Lynd River.

The first mention of this species was Leichhardt's brief note on his return to Sydney, here quoted from the Mitchell Library copy of "The Australian Journal of Commerce, Agriculture, and Politics" (n.s.), iii., March 26, 1846, supplement:—

"In a large water-hole of the Lynd we found a dead sawfish (pristis); in those of the Mitchell, alligators were seen by my black-fellows."

Sergeant Shipway's photograph shows a sawfish (speared through the head) with apparently eighteen teeth on each side of the rostrum, those nearest the head being rather long; the first dorsal fin originates well in advance of level of ventrals and is smaller than the second, whose lobe reaches the caudal which has an excavate posterior margin and distinct lower lobe; the pectoral angles are not rounded. The maximum length was given as five feet. This combination of characters separates Leichhardt's Sawfish from all other fossil and recent species of Pristidae.

Described and figured from the type-locality, Lynd River, North Queensland; found in freshwater billabongs, and seen also in the Walsh, Mitchell and Palmer Rivers by Sergeant Shipway.

Key to the recent species of Australian Sawfishes.

A. First dorsal fin originating well in advance of level of ventral origins; about eighteen teeth on each side of saw. . . . . *Pristiopsis leichhardti,* Whitley.

AA. First dorsal fin originating behind level of ventral origins.

B. Twenty-five or more teeth on each side of saw. . . . . *Pristis zijsron,* Bleeker.

BB. Eighteen to twenty-one teeth on each side of saw. . . . . *Pristis clavata,* Garman.

THE LAND MOLLUSCA OF NORFOLK ISLAND.

By Tom Iredale.

(Plates ii.-v.)

This article concludes the series of essays providing an introduction to the Land Mollusca of Australia and dependencies. The previous accounts, a Basic List of the Land Mollusca of Australia, a Basic List of the Land Mollusca of Papua, and the Land Mollusca of Lord Howe Island have all appeared in this Journal. A note of warning regarding the use of "Papua" in the above-mentioned article must be here mentioned. At the time of writing "Papua" was the official name of the south-eastern part of New Guinea, previously known as British New Guinea. At present it has been discarded, and Australian New Guinea is in use for "Papua" and the Mandated Territory.

Norfolk Island is an appanage of Australia, situated 930 miles north-east from Sydney, 400 miles north-west from New Zealand, 980 miles south-west from Suva, in Fiji, and 450 miles south-east from Noumea in New Caledonia. It is a compact island, some five miles long by three miles broad, surrounded by imposing cliffs from 200-400 feet high, save for a small low-lying patch on the south side, where the settlement is situated. The interior consists of a comparatively level plateau, averaging 400 feet high, intersected by narrow stream valleys. This rises to a height of just over 1,000 feet, the highest point, Mt. Pitt, being 1,044 feet. To the south lie two small islands—one, Nepean Island, a few acres in extent, half a mile south of the settlement; the other, Phillip Island, lying three to four miles further south, about a mile and a half long and three-quarters of a mile broad, elevated, rising to 900 feet. The latter is now uninhabited and almost barren, pigs and rabbits having entirely destroyed the abundant vegetation recorded one hundred odd years ago. Land shells were collected there abundantly, but even these now appear to be extinct. The main island now shows wide areas of well-grassed lands, long avenues and small patches of the stately Norfolk Island pine, broken hills and fertile valleys; only the slopes of Mt. Pitt, that are still unoccupied, giving an indication of early conditions. The climate is exceptionally mild, the thermometer ranging from between 56° and 82° Fahrenheit, with a mean of 68°, and an annual rainfall of 43 inches. The total acreage is 8,528 acres.

The above epitome of the physical characters of the island would not suggest an abnormal snail fauna, yet the quantity and diversity of species seem to be unparalleled on any similarly sized island. At the time the island was discovered by Europeans (1774) there were no human inhabitants, and when Australia was colonised in 1788 it was used as a penal settlement, and buildings were built, and part of the island cultivated. The settlement was abandoned in 1808, and seventeen years later it was again used as a prison for the worst kind of prisoner. This usage lasted for thirty years, when the convicts were withdrawn, and the islanders of Pitcairn Island were settled there, and it has continued a free settlement ever since.

The island was surveyed by the H.M.S. "Herald," on board of which was the great naturalist, John Macgillivray, who, of course, collected land shells.

Previously, twenty odd years before, Allan Cunningham, the famous botanist, had visited the island, and three species of snails were collected by him, providing the first known records of snails from the island. Curiously, these were all discovered on Phillip Island, and their mainland representatives seem to differ appreciably.

The great Australian shell collector, Brazier, had visited the island in 1854 while a boy, but in 1865 on board the "Curaçoa," under Wiseman, he made a good collection. An account of the voyage of the "Curaçoa" was written by Julius Brenchley, who was a visitor on the trip, and some of his collections were donated to the British Museum. A German collector, Graeffe, called at the island, and some species may have been described from his collections.

The first account of the land shells as a whole was drawn up by Sykes, in 1900, from the British Museum material, mostly collected by Macgillivray. Then Roy Bell, of the Kermadec Islands, went to Norfolk Island, on account of G. M. Mathews, and his results became startling. The description and record of his material were placed in the hands of Mr. H. B. Preston, who issued a preliminary account of many new species in 1913. War intervened, and his work was never concluded. A number of illustrations had been prepared under my supervision, as the whole of the material passed through my hands, and I retained an almost complete series of specimens and material. Preston's types went into the British Museum, but named paratypes and much material have been available for this revision.

Class Gastropoda.

Subclass Prosobranchia.

Order Pectinibranchia.

Family Realiidae (Omphalotropidae, *olim.*)

In my account of the Land Mollusca of Lord Howe Island I drew attention to the great distinction between the molluscs of that island and of this one. I there introduced two generic names for the two very different types represented on this island, but the problem now is the number of species and their nomination. One of the features of the fauna is the extreme localisation of forms from no apparent cause, and the occurrence in a subfossil state of many species, the subfossils showing variation from recent shells. Thus in this group, while the extremes show very distinctly, many apparent intermediates seem difficult to determine. The earliest named, *cerea,* has not been recognised, and may be an erroneous locality citation. Sykes allowed it without comment, although it had not been figured, and the type should have been available. It was described as *"laevigata,"* and Sykes described as new the only smooth species, the differences being in size and whorl convexity. He also described *Omphalotropis brenchleyi* of the *navigatorum* series, sculpture less marked, allowed *albocarinata* Mousson, "the sculpture has become obsolete," and *navigatorum* from the Navigator Islands, a broader, slightly larger, and more highly coloured variety. Many thousands have been examined, and at first sight the three, *brenchleyi, albocarinata* and *"navigatorum,"* might be allowed intergradation, but separate colonies seem to show distinction. For the very large boldly sculptured *"navigatorum"* the name *fortilirata* may be used.

Genus Duritropis, Iredale.

Duritropis Iredale, Austr. Zool., Vol. 10, p. 301, May 10, 1944. Orthotype, *Omphalotropis brenchleyi,* Sykes.

The definition reads: "Shell small, conical, apical whorl smooth, turbinate, later whorls sculptured with longitudinal wavy ribs, suture impressed, whorls convex, strong peripheral keel with pronounced umbilical keel, umbilical area large, umbilicus narrow, operculum paucispiral, horny."

Duritropis brenchleyi, Sykes.

Omphalotropis brenchleyi Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 145, pl. 13, fig. 18, October, 1900. Norfolk Island (Coll. Brenchley).

Sykes' description gives no particulars as to number of longitudinal ribs, save that the sculpture is less marked than that of *"navigatorum."* A large number from Ball's Bay shows a broad shell with about twenty lirae showing on face, between forty and fifty on last whorl, the largest shell measuring 7 mm. by 4.25 mm.; the coarsest of this series shows about thirty odd ribs on last whorl.

Duritropis albocarinata, Mousson.

Omphalotropis albocarinata Mousson, Journ. de Conch. Vol. xxi., p. 115, pl. vii., fig. 3, April 1, 1873. Norfolk Island.

A smaller shell, comparatively broader, with the ribbing almost obsolete, about forty fine ribs may be counted. Associated with preceding but easily picked out. If it be proved that these are all variants, then this will be the specific name. The figure here given was drawn from a specimen regarded by Preston as a distinct species.

Duritropis fortilirata, *sp. nov.*

Omphalotropis navigatorum Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 145, October, 1900. Norfolk Island.

As Sykes differentiated this as a variety of *navigatorum* Pfeiffer, from the "Navigator Islands," it is here named. The shell is similar to *brenchleyi,* but has outstanding lirae, twenty to twenty-five on last whorl, and is found of much larger size than the type of *brenchleyi.*

Genus Telmosena, Iredale.

Telmosena Iredale, Austr. Zool., Vol. 10, p. 301, May 10, 1944. Orthotype, *Omphalotropis suteri* Sykes.

Defined thus: "Shell small, acutely conical (awl-shaped), apical whorls smooth, dome-shaped, later whorls smooth, suture lightly impressed, whorls little convex, no peripheral keel, umbilical keel strong, umbilical area very small, perforation obsolete, operculum normal."

Telmosena suteri, Sykes.

Omphalotropis suteri Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 146, pl. xiii., fig. 15, October, 1900. Norfolk Island.

This is a long narrow shell, measuring 6 mm. by 2.8 mm., smooth, with flattened whorls, and therefore cannot be *Hydrocena cerea* Pfeiffer, Proc.

Zool. Soc. (Lond.), 1857, pp. 112-3, August 15/September 28, described from "Norfolk Island," as "ovatoconica, spira convexa, laevigata," measuring 4½ mm. by 2-2/3 mm. The latter has not been recognised in the large collections studied and may be exotic.

Family Helicinidae.

Two species of *Helicina* (*H. pictella* and *H. norfolkensis*) have been described by Pfeiffer (Proc. Zool. Soc. (Lond.), 1856, pp. 391-2), as from Norfolk Island, but no such shells have been found at Norfolk Island, and undoubtedly the locality is erroneous in both cases.

Family Diplommatinidae.

Genus Palmatina, Iredale.

Palmatina Iredale, Austr. Zool., Vol. 10, p. 304, May 10, 1944. Orthotype, *Palaina coxi* H. Adams.

This genus was defined: "Shell small, up to 3.5 mm., elongate, apex a little elevated, sinistral, sculpture of erect sharp longitudinal lamellae, last whorl completely rounded, aperture circular, almost free, mouth duplicate, operculum circular, large, filling mouth."

Preston described two additional species, and indicated two more in MS., and there appears to be at least these five species.

Palmatina coxi, H. Adams.

Palaina coxi H. Adams, Proc. Zool. Soc. (Lond.), 1868, p. 16, pl. iv., fig. 14, May 28. Norfolk Island (ex J. C. Cox, coll. Brazier).

Diplommatina wisemani Brazier, Journ. de Conch., Vol. xviii., p. 84, January 1, 1870, cited as synonym, as of MS., 1865, when collected; also Proc. Zool. Soc. (Lond.), 1869, p. 560, April 7, 1870 (*wisemanni*).

Palaina norfolkensis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 537, December 1, 1913. Stockyard Creek, Norfolk Island (R. Bell).

Comparison of the descriptions alone prove the identity of these, and shells sent to the Australian Museum under the name "*coxi*," differ from the true *coxi* and are here described. Preston's measurements of his *norfolkensis* are incorrect, having been transposed with those of *P. belli.* The correct measurements are: Altitude, 3.5; major diameter, 1.75 (nearly) mm., and a figure of the type of *P. norfolkensis* Preston, is here offered.

Palmatina belli, Preston.

Palaina belli Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 538, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

The description is excellent, save the measurements, which should read: Alt., 2.5; diam. maj., 1.25 mm., the type being illustrated herewith. The ribbing is regular throughout, the first whorl and a half conical, smooth, the next more swollen, about fifteen ribs countable on face, interstices striate, the succeeding whorl showing eighteen on a deeper, more swollen whorl, the last whorl being still deeper, but less swollen, and with about a dozen ribs showing.

Palmatina quintali, *sp. nov.*

Shell small, sinistral, elongate, white, mouth circular, projecting, almost

free. The first whorl is dome-shaped, smooth, the second ribbed finely, a little larger; the third greatly increased, with a dozen ribs countable, interstices striate, the next still increasing, little deeper, with only twelve ribs notable, while the last whorl is deeper, but not increasing, and there are only ten ribs on face.

The type measures 3 mm. in height, and 1.5 mm. in breadth, and was collected by H. C. Quintal in the Harper Road Valley, north-east coast. This was picked out of debris, leaf, etc., sent by Mr. Quintal, and with it was another specimen of the same size, but with quite different ribbing, the first adult whorl having twelve ribs, as the preceding, but in the next the ribs are more widely spaced and only nine are evident, and on the next two there are still only eight or nine showing. As this is obviously a different species it may be named *P. addenda,* sp. nov., and many more species may still be discovered.

FERMEPALAINA, *subgen. nov.*

Type, *Palaina nancena,* sp. nov.

The species Preston determined as *coxi* has proved to be very different, and moreover belongs to a different group, to be associated with the true *Palaina* from Lord Howe Island. The shells differ from those of the preceding genus, *Palmatina,* in being more closely coiled, the whorls less convex, the mouth not projecting, the lips less expanded, and appressed to the body whorl, and with the operculum very small or missing. In *Palmatina* the majority of the specimens retain the notable operculum, but in this group, although many specimens have been examined, no operculum has been seen. Although similar to *Palaina* the shells lack the depression on the face of the last whorl, characteristic of that genus, hence the subgeneric name here proposed for the Norfolk Island species.

PALAINA NANCENA, *sp. nov.*

Shell small, white, elongate, whorls rounded, but less convex than the preceding, sutures much less deep, though well marked, mouth rounded, circular, lips a little reflected, appressed to the base of the last whorl and not projecting notably, no operculum seen. Apical whorls two, conical, smooth, succeeding four fairly regularly ribbed with twelve to fifteen ridges seen on face of whorl, interstices between ribs concentrically striate. While the whorls normally increase until the last the shell is more regular in form. The shell is 2.5 mm. high, and 1.25 mm. broad, and the type locality is Ball's Bay. A series from Duncombe Bay, north-west coast, is similar, but the shells are smaller, measuring 2 mm. in height by 1 mm. in breadth. The ribbing is a little finer, numbering fifteen to eighteen ribs on the face, more ribs on earlier than later whorls, and this may be named *P. nancena bera,* subsp. nov., although it may later prove to be a distinct species.

PALAINA PITTENSIS, *sp. nov.*

Shell small, white, whorls rounded, flattened peripherally, sutures deep, mouth circular, small, lips expanded, but mouth not projecting, appressed to the base. Apical whorls one and a half smooth, first adult whorl with about fourteen ribs on face, second with ribs more distant, only about ten being counted, while the last shows about twelve ribs; between the ribs fine concentric striae can be seen on all the whorls. Height, 2.5 mm.; breadth, 1.1 mm. Collected on Mount Pitt by H. C. Quintal.

Subclass PULMONATA.

Order STYLOMMATPHORA.

Family ELASMATINIDAE.

Preston described two species and two subspecies under the generic name *Tornatellina,* and added two others in MS. At a later date Pilsbry monographed the group and divided it into many genera, and later still Odhner, by means of anatomical research, proved that the original *Tornatellina* had nothing to do with the well-known traditional Tornatellinids, and so Elasmatinidae comes into use. By means of columellar toothing and usage of juveniles, shells, which look very much alike, can be separated, and thus we find that two genera are represented in this fauna.

Genus TORNATELLINOPS, Pilsbry.

Tornatellinops Pilsbry, Man. Conch. (Tryon), Ser. ii., Vol. xxiii. (pt. 91), p. 169, December 1. Orthotype, *Tornatellina novoseelandica,* Pfeiffer.

In this genus the columella bears no lamella, either in the adult or in the juvenile state, the columella being merely twisted, the species being generally long and slender; the shells of the succeeding genus were commonly broader.

TORNATELLINOPS NORFOLKENSIS, Preston.

Tornatellina norfolkensis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 536, December 1, 1913. Ball's Bay, Norfolk Island (R. Bell).

A series from the type locality includes many juveniles, and these have no lamella upon the columella. Measurements: Alt. 3.5, diam. maj. 1.25 mm.

Genus TORNELASMIAS, Iredale.

Tornelasmias Iredale, Austr. Zool., Vol. 10, p. 308, May 10, 1944. Orthotype, *Tornelasmias capricorni,* Iredale.

This name was introduced for the Lord Howe Island shells which show only a twisted columella in the adult, but which show in the juveniles columellar teeth. Most of the Norfolk Island forms belong to this group.

TORNELASMIAS MOOHUENSE, Preston.

Tornatellina norfolkensis moohuensis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 537, December 1, 1913. Moohu Stone, a small islet off the coast of Norfolk Island.

This appears to be the mainland form also, many examples from Duncombe Bay showing juveniles with the toothed columella. Alt. 3.5, diam. maj. 1.5 mm. The juvenile was named as distinct in MS. by Preston, even as in the succeeding species.

TORNELASMIAS NEPEANENSE, Preston.

Tornatellina norfolkensis nepeanensis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 537, December 1, 1913. Nepean Island (R. Bell).

Tornatellina duplicilamellata Preston. *ib., id.*

This species is separated from the preceding by the development of the parietal lamella. At the time Preston wrote it was not suspected that a shell bearing columellar lamella would lose it with age, so that the young one was described as novel, the measurements, 2.25 x 1.5 mm. as against the adult, 3.5 x 1.5 mm.

Family NESOPUPIDAE.

Genus NESOPUPARIA, Pilsbry.

Nesopuparia Pilsbry, Man. Conch. (Tryon), Ser. 2, Vol. 27, p. 226, March, 1926. Orthotype, *Vertigo norfolkensis,* Sykes.

Defined as "Large Nesopupae of conic shape with a long umbilical suture; aperture about as in *Nesopupa* proper." On pl. 29, fig. 16, he showed the aperture with eight teeth, but one is abnormal, seven being normal. Sykes gave a crude recognisable figure showing the seven teeth.

NESOPUPARIA NORFOLKENSIS, Sykes.

Vertigo norfolkensis Sykes, Proc. Mal. Soc. (Lond.), Vol. 4, p. 145, pl. 13, fig. 13, October, 1900. Norfolk Island, in the crevices of the bark of a Dracena.

Living shells are rich brown, not isabella nor "flavida," and dull, not gleaming nor "subnitens," the white mouth showing up vividly against the brown edges of the lips. The almost fully grown shell is toothless, and then five teeth appear simultaneously, the angular, parietal, columellar and the two lower palatals. These develop strongly and the mouth thickens as the basal and upper palatals are produced, while a minute infra-parietal lamella also appears. I have not seen an abnormal duplicate fold as shown by Pilsbry, but in one senile shell tubercles are developed between the basal and palatal, and between the two lower palatals, the medium palatal being strongly curved. The shell is minutely perforate, until it is three-quarters grown, when the reflected columella completely closes the perforation.

Family PUPISOMIDAE.

Genus IMPUTEGLA, Iredale.

Imputegla Iredale, Austr. Zool., Vol. viii., p. 305, March 12, 1937. Orthotype, *Pupisoma circumlitum,* Hedley.

As an Appendix in the Lord Howe report, I added a species belonging to this genus, and apparently this is widely spread, but on account of its habits is commonly overlooked. It has been found on the leaves of orange trees, and also buried in the debris underneath, and it may be repeated that *Elasmias* was almost overlooked at the Kermadec Islands through similar habits. During rain it was observed crawling on pepper plant leaves, but in dry weather it had vanished, apparently going to earth. Among debris sent by H. C. Quintal from Mount Pitt specimens of an *Imputegla* were sorted out, and it had escaped observation on the trees where it may live.

IMPUTEGLA PERRITA, *sp. nov.*

Shell small, turbinate, thin, translucent, imperforate, dull brown.

Whorls three, convex, sutures impressed, whorls increasing rapidly, last whorl being bulk of shell. First whorl very small, smooth, other whorls very finely striate, with few distant flattened lamellae, more distinct on base. Outer lip thin, mouth large, circular, columella a little curved, reflected.

Breadth, 1.25 mm.; height, 1 mm. Mount Pitt (H. C. Quintal).

This is smaller than the Lord Howe species, and shows distant lamellae which were not seen on that shell.

Family Succineidae.

Sykes named one species of *Succinea* (*norfolkensis*), placing it under the subgenus, *Tapada*, "found in great plenty in the valley." Preston added two species from Nepean Island, found in a subfossil state only. Comparatively recently (Proc. Mal. Soc. (Lond.), Vol. xxiii., p. 299, July 15, 1939), Quick has given some particulars of the shell, jaw and radula of the shells named *norfolkensis*. The shell is finely characteristically sculptured, but the jaw and radula are distinctive, so that a generic name is necessary.

Genus Spirancinea, *nov.*

Type, *Succinea norfolkensis*, Sykes.

Shell succineiform, with fine clathrate sculpture, jaw large, striated, and radula with formula, $13 + 4 + 10 + 1 + 10 + 4 + 13$, the central being very large, the four outer marginals being intermediate in character between the marginals and laterals. Perhaps more nearly related to *Papusuccinea* than to *Austrosuccinea*.

Spirancinea norfolkensis, Sykes.

Succinea (*Tapada*) *norfolkensis* Sykes, Proc. Mal. Soc. (Lond.), Vol. 4, p. 144, pl. xiii., fig. 12, October, 1900. Norfolk Island.

Measurements: Alt., 12; diam. max., 7.2 mm.

Spirancinea nepeanensis, Preston.

Succinea nepeanensis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 536, December 1, 1913. Nepean Island, subfossil (R. Bell).

Succinea humerosa, id., ib. Not *S. humerosa* Gould, Proc. Bost. Soc. Nat. Hist., Vol. ii., p. 183, 1848.

Subfossils show great variation so as the earlier name is preoccupied, the one name can be used for all the Nepean Island shells, the type of *nepeanensis* being here figured.

Family Paralaomidae.

Preston introduced three species in the genus *Paralaoma,* proposed a couple of months previously for a Kermadec series. Three more species were later added in MS., and most seem normal species of the genus.

Genus PARALAOMA, Iredale.

Paralaoma Iredale, Proc. Mal. Soc. (Lond.), Vol. x., p. 380, September, 1913. Haplotype, *Paralaoma raoulensis*, Iredale.

These minute depressedly turbinate shells live in dry places.

PARALAOMA ORESTIAS, Preston.

Paralaoma orestias Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 534, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

PARALAOMA PERMINUTA, Preston.

Paralaoma perminuta Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 535, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

PARALAOMA DEPRESSIOR, Preston.

Paralaoma depressior Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 535, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

These three were completely described, but no differential features were indicated. The first-named is quite normal for the genus, but is finely striate with somewhat distant ribs, interstices minutely longitudinally striate, umbilicus narrow, deep. The third (*depressior*) is a little more depressed, the sculpture less marked, the umbilicus a little wider. The second (*perminuta*) is smaller, and a little abnormal, the base being concentrically striate and flattened, and the umbilicus is rather wide; alt. 25 mm. should be .5 mm.

The three species, later separated from Quintal's sendings of debris from Mount Pitt, are more difficult to deal with from the cotypes available. The species named *P. nobbsiana* seems to be identical with *orestias*, and the name would not have been mentioned save that specimens are in other Museums under the name. The second, *P. ahena*, is very distinct, but not a normal member of the genus, recalling *Paralaoma lidgbirdensis* from Lord Howe Island, for which was introduced the subgenus *Semilaoma*. The third called *Laoma flavida* is not referable to the family, but is at present unable to be located, and may be temporarily associated here with the generic name *Laomopa* hereafter described.

PARALAOMA DUNCOMBEI, *sp. nov.*

Shell small, turbinate, brown, whorls convex, umbilicus rather wide, sculpture of fine radials. From Quintal's sendings of debris from Duncombe Bay a large number of minute shells was separated, and probably many more new species have to be named. This *Paralaoma* differs from all the preceding in being larger, more elevated, with more rounded whorls, the peripheral subkeeling being obsolete, the umbilicus wider, more open, the mouth rounded, the columella slanting, little reflected. The sculpture is similar to those, slanting radial riblets rather distant with fine radial threads between, but the base shows few of the stronger radials and is crossed by fine concentric striae. Breadth, 2.5 mm.; height, 1.25 mm.

PARALAOMA AHENA, *sp. nov.*

Shell small, depressedly turbinate, brown, whorls convex, sutures im-

pressed, rather more tightly coiled than usual, ribbing regular, umbilicus narrow. The apical whorl is smooth, the three adult whorls closely sculptured with fine radial ribs, the interstices radially finely threaded, the base finely ribbed. Mouth circular, columella straight. Breadth, 2 mm.; height, 1 mm. Mount Pitt (H. C. Quintal).

Genus LAOMOPA, *nov.*

Type, *L. flavida,* sp. nov.

Shell minute, turbinate, narrowly umbilicate, spire a little elevated, whorls rounded, rather closely coiled, sutures impressed, last whorl with a faint peripheral keeling, mouth transversely ear-shaped, outer lip thin, columella straight, not reflected, umbilicus deep, narrow, base convexly flattened, sculpture microscopical striae.

LAOMOPA FLAVIDA, *sp. nov.*

As above, colour pale fawn. Breadth, 1 mm.; height, .6 mm. This differs very decidedly from true *Laoma,* and from *Paralaoma* by its flattened convex base and narrow umbilicus.

Genus CHRISTIANOCONCHA, *nov.*

Type, *C. quintali,* sp. nov.

This shell is very like *Paralaoma,* superficially, but there are two parietal lamellae. These are small, placed together medially and are quite different from the "Charopid" lamellae as seen in *Norfolcioconcha.*

Shell small, turbinate, whorls convex, sutures impressed, mouth subcircular, a little quadrate, umbilicus moderately wide.

CHRISTIANOCONCHA QUINTALI, *sp. nov.*

Shell small, as above, pale fawn, sculpture of close radial riblets, interstices striate, apical one and a half whorls smooth, remaining three regularly sculptured, lips of mouth thin, mouth a little quadrangular through subperipheral keel and straight columella. Breadth, 1.75 mm.; height, 1 mm. Mount Pitt (H. C. Quintal).

A similar smaller shell was found at Duncombe Bay, apparently less boldly sculptured, but with similar parietal lamellae.

Family CHAROPIDAE.

No Charopids had apparently been described until Hedley introduced *Endodonta norfolkensis,* but when Sykes drew up his list Hedley sent him drawings of three of four species described by Cox years previously. One was placed definitely in *Charopa,* but was not figured as the type was broken, the other three tentatively associated with *Charopa,* as Hedley at that time was mainly dealing with anatomical features, and little stress was paid to conchological characters. From the drawings none was at all like *Charopa* from shell form, and none is at all related.

Preston proposed two species of *Charopa,* as then restricted, and brought in a genus for Hedley's *Endodonta norfolkensis,* and another new genus for

a quaint new species. Two or three more were later differentiated by Preston in MS.

Genus CRYPTOCHAROPA, Preston.

Cryptocharopa Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 534, December 1, 1913. Orthotype, *C. atlantoididea* Preston = *Helix exagitans* Cox.

Preston wrote: "Shell planulate, incrusted with an agglutinated mass of earth and vegetable matter, which broadens out at the periphery into a serrated fringe. . . . The shell has a superficial resemblance to *Charopa*, though probably having no close relationship with that genus."

CRYPTOCHAROPA EXAGITANS, Cox.

Helix exagitans Cox, Proc. Zool. Soc. (Lond.), 1870, p. 83, June 2. Norfolk Island, found in damp places in the pine forests under leaves (Brazier).

Cryptocharopa atlantoididea Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 534, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

An excellent description has been given by Preston, the species being unmistakeable.

Genus NORFOLCIOCONCHA, Preston

Norfolcioconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 535, December 1, 1913. Orthotype, *Endodonta norfolkensis,* Hedley.

Diagnosed thus: "Shell minute, subhyaline, turbinate, with open umbilicus; sculptured with transverse riblets; aperture armed with two parietal lamellae and two lamellae on the outer wall." Hedley (Austr. Zool., Vol. iii., p. 219, May 9, 1924) observed: "This shell is turbinate with an elevated spire, and small perforation; the remarkable feature is the development of the parietal lamellae, the two blades of which plunge deep into the aperture."

As the Land Mollusca of the Kermadec Islands have been compared with that of Norfolk Island, the differences between the toothed Charopids of each island may be here recorded. I described two different forms under the generic name *Ptychodon,* but with the more exact methods, now in use, these must be separated from that genus. The larger, *Ptychodon royanus,* was a small discoidal, widely umbilicated shell, protoconch finely radially sculptured, adults finely lamellate, threads between, mouth strongly armed, three long slender parietal lamellae, with five similar internally on the outer lip. This may be called *Kermodon,* gen. nov. The smaller, *Ptychodon pseutes* and *amandus,* are more like the present genus, but are less turbinate; the armature is much more complex; there is only one bifurcate lamella on the parietal wall, two crass conical teeth on the columella and half a dozen lamellae on the lower half internally of the outer lip. The shell is narrowly umbilicate, the protoconch radially threaded, the adult sculpture finely lamellate, narrow, interstices smooth save when growth threads appear, forerunners of new lamellae. A new genus, *Huonodon,* is introduced, *P. pseutes* being named as type.

NORFOLCIOCONCHA NORFOLKENSIS, Hedley.

Endodonta norfolkensis Hedley, Rec. Austr. Mus., Vol. iii., p. 152, pl. 28, figs. 4-5, December 11, 1899. Norfolk Island, in guava forest on hill side (J. Brazier).

Measurements: Breadth, 1.44 mm.; height, 1 mm. Parietal teeth both strong, and slight columellar basal thickening.

NORFOLCIOCONCHA IOTA, Preston.

Norfolcioconcha iota Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 535, December 1, 1913. Limestone Quarry, south-east coast of Norfolk Island, in subfossil state (R. Bell).

The measurements read: "Alt., .25; diam. maj., 1 mm." Hedley's species was only 1.44 mm. in diameter, and obviously Preston's altitude was printed incorrectly. From material from Duncombe Bay many specimens were sorted out of three size-series, the largest going over 2 mm. in diameter, and being more elevated, while the smallest would be near Preston's *iota*. As there is so much differentiation seen among the Norfolk Island shells these may represent three species, and may even provide local subspecies. The largest, measuring 2 mm. in breadth by 1.25 in diameter, is more conical than typical shells, has finer sculpture, especially on the base, the interstices narrow and concentric striation cannot be noted, the umbilicus narrower. These may be called *N. norfolkensis inimica,* subsp. nov. Preston noted that in *iota* "the base of shell was sculptured with revolving striae," and this may have been seen more clearly in the subfossil specimens. In the recent shells sometimes this spiral striation may be observed by means of a high power, and at others it cannot be discerned. Whether it is constant or not seems very dubious.

Genus PENESCOSTA, Iredale.

Penescosta Iredale, Austr. Zool., Vol. 10, p. 320, May 10, 1944. Orthotype, *Charopa mathewsi,* Preston.

These small Charopids are unlike any others yet seen, being small, very thin, almost discoidal, upper surface flattened, apical whorls smooth, sculpture regular, curved thin lamellae, interstices reticulate, base flat, widely umbilicated, mouth subquadrate, lips thin, untoothed within.

PENESCOSTA MATHEWSI, Preston.

Charopa mathewsi Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 533, December 1, 1913. Ball's Bay, Norfolk Island (R. Bell).

Measurements: Alt., .75 mm.; diam. maj., 2.5; diam. min., 2.25 mm. Whorls four and a half. Colour chestnut brown. Sculpture well marked regular curved riblets, 45-50 on last whorl, interstices reticulate.

PENESCOSTA SORORCULA, Preston.

Charopa sororcula Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 533, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

Smaller, paler in colour, pale yellowish brown, sculpture finer, less regular, the apex a little exsert, and last whorl not descending makes the aperture less quadrate, more obliquely ovate. Size: Alt., .5 mm.; diam. maj., 1.5 mm.

PENESCOSTA HARPERENSIS, *sp. nov.*

Shell smaller than *P. mathewsi,* of which it might be only a subspecies; the whorls narrower, the sculpture finer, sixty or more ribs on last whorl

which does not descend, the mouth subcircular, colour dull brown. Size: Alt., .5 mm.; diam. maj., 2 mm. From the Harper Valley, north-east Norfolk Island (from debris sent by H. C. Quintal).

PENESCOSTA DUNCOMBENSIS, *sp. nov.*

From debris sent by H. C. Quintal from Duncombe Bay, north-west point of Norfolk Island, many specimens of *Penescosta* were sorted out, the largest here named being very distinct. Shell small, flattened, but whorls more rounded, the apex elevated, last whorl descending, whorls narrow, umbilicus very wide, mouth small, elongate oval. The sculpture is of distant fine lamellae, the interstices regularly finely striate, concentric striae obsolete. Colour pale yellow brown. Size: Height, 1 mm.; breadth, 2.25 mm. Amongst these were many smaller shells of similar form, but more elevated comparatively, paler coloration, sculpture coarser, mouth larger, umbilicus less wide and only 1.5 mm. broad by .75 mm. high. This may be called *P. piger*, sp. nov.

Genus FRUSTROPA, *nov.*

Type, *F. alea*, sp. nov.

A small, more rounded Charopid, recalling the Kermadec Island *macgillivrayi*, with narrow umbilicus, slightly elevated spire, rounded whorls, apex large, smooth, mouth sub-ear-shaped, no internal toothing.

FRUSTROPA ALEA, *sp. nov.*

Shell small, depressedly turbinate, thin, upper surface convex, whorls rounded, last whorl descending, umbilicus narrow, deep, mouth reversed, ear-shaped, untoothed internally. Colour pale cream. Apex a whorl and a half smooth, three adult whorls sculptured with fine curved lamellae, closely packed, interstices smooth. Size: Breadth, 2 mm.; height, 1.25 mm. From debris collected by H. C. Quintal on lower slopes of Mount Pitt. Every lot of debris sent showed minute new species, so that there is probably a very large number of such small mollusca yet to be discovered on this island.

ZONITOID SNAILS.

Sykes allotted eleven species to this series without worrying about families, merely arranging them under the generic names, *Microcystis, Trochonanina, Fretum* (a new name for *Eurypus* Semper, preocc.), *Rotula, Medyla, Sitala* and *Carthaea*. I later replaced *Medyla* by *Fanulum*, while Gude proposed *Advena* for the *Rotula* species. Preston then introduced *Greenwoodoconcha* for the *Microcystis* forms, *Roybellia* for the *Trochonanina* species, and *Quintalia* for the Norfolk Island *"Carthaea."* Preston added *Allenoconcha* for some *Microcystis*-like species, *Mathewsoconcha, Belloconcha, Iredaleoconcha, Pittoconcha, Macgillivrayella* and *Johannesoconcha*. Burrington Baker prepared a series of essays on the Zonitid Snails of Fiji eastwards, which appeared in the Bulletins of the Bernice P. Bishop Museum, No. 158 (October 10, 1938), No. 165 (January 20, 1940), and No. 166 (February 5, 1941). Unfortunately, obsessed by the abnormal value of unstable anatomical details, Baker's essays are not as useful as they should have been, and it is difficult to arrange the many Norfolk Island groups in his scheme. Baker himself more or less ignored Preston's groups, as he did not know their anatomy, and would not accept the work of other anato-

mists, nor utilise the conchological known features, though he admitted (Bull. 158, p. 6): "In the Zonitids, and especially in the Helicarionidae, one is constantly reminded that positive shell characters (e.g., definite sculpture, columellar folds or teeth) are very useful in classification." Hereafter the species are classified from their conchological features, and it may be laid down as an axiom—that no sound classification will be achieved save by the co-operation of a conchologist, who will do the basic work, with an unprejudiced anatomist who will seek to prove the accuracy or otherwise of the conchologist's conclusions, and then debate the few instances where there appears to be disagreement of facts.

Family Microcystidae.

Some Norfolk Island shells appear to fall into this family, though Baker (Bull. 158, p. 57) observes: "The genus *Microcystis* is now limited to a group of species from the Austral and Cook Islands."

Genus Allenoconcha, Preston.

Allenoconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 523, December 1, 1913. Orthotype, *Allenoconcha basispiralis*, Preston.

Defined thus: "Shell thin, corneous, depressedly turbinate or almost planulate, imperforate, microscopically spirally striate." The shells allotted to this genus are small, flattish, and generally unicolor, with no very striking conchological feature, and may later be dispersed when anatomical data are understood.

Allenoconcha basispiralis, Preston.

Allenoconcha basispiralis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 523, December 1, 1913. Ball's Bay, Norfolk Island (R. Bell).

Measurements: Alt., 2.5; diam. maj., 4.5; diam. min., 4 mm. Well described, the type is here figured.

Allenoconcha belli, Preston.

Allenoconcha belli Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 523, December 1, 1913. Steel's Point, Norfolk Island (R. Bell).

Measurements: Alt., 2; diam. maj., 3.5; diam. min., 3.25 mm. Well described, the type is now figured.

Allenoconcha mathewsi, Preston.

Allenoconcha mathewsi Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 524, December 1, 1913. Ball's Bay, Norfolk Island (R. Bell).

Measurements: Alt., 2.25; diam. maj., 4.75; diam. min., 4.25 mm. Well described.

Allenoconcha mons-pittensis, Preston.

Allenoconcha mons-pittensis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 524, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

Measurements: Alt., 1.5; diam. maj., 4.25; diam. min., 3.75 mm. Well described, figures of the type are here given.

ALLENOCONCHA PERDEPRESSA, Preston.

Allenoconcha perdepressa Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 524, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

Measurements: Alt., 1.25; diam. maj., 3.25; diam. min., 3 mm. Well described, figures of the type are here given.

ALLENOCONCHA COYANA, Preston.

Allenoconcha royana Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 525, December 1, 1913. Duncombe Bay, Norfolk Island (R. Bell).

Measurements: Alt., 2; diam. maj., 4.75; diam. min., 4 mm. Well described.

ALLENOCONCHA CONGENER, Preston.

Allenoconcha congener Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 525, December 1, 1913. Duncombe Bay, Norfolk Island (R. Bell).

Dimensions: Alt., 3.25 (nearly); diam. maj., 4.75; diam. min., 4.25 mm. The altitude is wrong: it should be 2.25 mm.; a figure of the type here presented.

ALLENOCONCHA ? RETINACULUM, Preston.

Nitor retinaculum Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 532, December 1, 1913. Ball's Bay, Norfolk Island (R. Bell).

The reason for the allocation of this species to *Nitor* is now unknown, but it has not the slightest resemblance nor relationship to the true *Nitor* of the Australian continent. Perhaps it was the faint subangulation of the periphery, but it seems of little value, while the columella thickening is still a factor of doubtful worth. Measurements: Alt., 1.5 (nearly); diam. maj., 3; diam. min., 2.5 mm. Two other smaller species were later named in MS. from Quintal's material, and they appear to be near *Allenoconcha,* and have been left until a deeper study of these difficult shells can be made. Figures of the type of *retinaculum* are here given.. As it is not a true *Allenoconcha,* the differences may be given subgeneric value with the new name *Buffetia.*

Genus GREENWOODOCONCHA, Preston.

Greenwoodoconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 525, December 1, 1913. Orthotype, *Microcystis nux,* Sykes.

Defined thus: "Shell turbinate, with somewhat convex base, imperforate, moderately solid, finely spirally striate." The shells allotted to this genus differ from those of the preceding in their more turbinate form, more solid shell and marked coloration.

GREENWOODOCONCHA NUX, Sykes.

Microcystis nux Sykes, Proc. Mal. Soc. (Lond.), Vol. 4, p. 139, pl. xiii., figs. 4-5, October, 1900. Norfolk Island, under dead leaves.

Dimensions: Alt., 4; diam. max., 7 mm. A small, compactly coiled species, usually concolor yellowish, imperforate, though Sykes wrote "subperforata."

Greenwoodoconcha castaneocincta, Sykes.

Microcystis castaneocincta Sykes, Proc. Mal. Soc. (Lond.), Vol. 4, p. 139, pl. xiii., figs. 8-9, October, 1900. Norfolk Island, under dead leaves.

Dimensions: Alt., 3.9; diam. max., 7.8 mm. Found with the preceding, differing in coloration and the relative proportions of height and breadth. Many specimens from Ball's Bay are smaller and more elevated than Mount Pitt shells, and are called *G. c. sericea* subsp. nov. Figures of this form are here given.

Greenwoodoconcha tomi, Preston.

Greenwoodoconcha tomi Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 525, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

Measurements: Alt., 3; diam. maj., 5.25; diam. min., 4.75 mm. Well described; figures of the type are here presented.

Genus Iredaleoconcha, Preston.

Iredaleoconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 530, December 1, 1913. Orthotype, *Iredaleoconcha inopina,* Preston.

The diagnosis reads: "Shell heliciform, depressed, corneous, *imperforate,* having a widely grooved suture, which is continued on the last whorl as a supraperipheral channel." Recalling *Diepenheimia,* Preston (Ann. Mag. Hist., Ser. 8, Vol. xii., pp. 433-434, November, 1913) from the Obi Islands, East Indies, but the latter is perforate, and the grooved suture coincidental.

Iredaleoconcha inopina, Preston.

Iredaleoconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 530, December 1, 1913. Limestone Quarry, Norfolk Island (R. Bell).

A small, yellowish, shining, suborbicular shell, said to have been found also at Mount Pitt. Unfortunately, drawings were not made of this, and the next species, and no specimens are available. Reference must then be made to the description when refound, the channelled suture being characteristic, the size being given as: Alt., .75; diam. maj., 2; diam. min., 1.75 mm.

Iredaleoconcha caloraphe, Preston.

Iredaleoconcha caloraphe Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 531, December 1, 1913. Duncombe Bay, Norfolk Island (R. Bell).

This is a larger shell, brown in colour, measuring: Alt., 2; diam. maj., 4.25 (nearly); diam. min., 3.75 mm.

Genus Pittoconcha, Preston.

Pittoconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 531, December, 1, 1913. Orthotype, *Pittoconcha concinna,* Preston.

Defined: "Shell imperforate, corneous, turbinate, swollen, peripherally carinate, spirally striate, and transversely costulate."

Pittoconcha concinna, Preston.

Pittoconcha concinna Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 531, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

Well described. Dimensions: Alt., 1.75; diam. maj., 3 mm. Figures of the type are here given.

Genus Nancibella, *nov.*

Type, *Helix quintalae,* Cox.

Shell small, flat-topped, glassy, manywhorled, imperforate, striate above, smooth below, mouth subquadrate, lips thin, periphery strongly keeled. This beautiful form recalls *Allenoconcha,* but is very distinct in its numerous whorls, carinate periphery, etc.

Nancibella quintalae, Cox.

Helix quintalae Cox, Proc. Zool. Soc. (Lond.), 1870, p. 82, June 2. Norfolk Island.

Charopa ? quintalae Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 143, fig. ii. in text, October, 1900. Type figured by Hedley.

A specimen of this delightful species was recovered from debris sent from the lower slopes of Mount Pitt by H. C. Quintal, a son of the Quintal after whom it was named. The number of whorls in the type is eight, and the size was given as .14 x .12 x .08 in.; that is, greatest breadth, 3.5 mm.; less breadth, 3 mm.; height, 2 mm.

Family Fanulidae.

There is a number of Trochomorph Zonitids, which are apparently closely related to the Microcystine series, and these were arranged under the name *Diastole* by Baker, who curiously wrote: "*Diastole* and *Fanulum* appeared simultaneously; as the first reviser, I definitely prefer the former, although, scientifically, the systematic position of the latter is still dubious." This quaint reasoning is inexplicable. *Fanulum* has definite priority over *Diastole,* and if a worker claimed to be a "reviser" he should know his facts. At the time of introduction the Norfolk Island *insculpta* was associated with the Kermadec type of *Fanulum,* and Suter (Proc. Mal. Soc. (Lond.), Vol. iii., p. 330, 1899) had discussed the anatomy of this mollusc, while that of the type of *Diastole* (*Helix conula* Pease) was then unknown.

However, the matter is of little importance, as *Fanulum* does not seem to be closely allied to any member of the incongruous association arranged by Baker under *Diastole.* Again, the Norfolk Island species may not be really related to *Fanulum,* as there are good conchological differences, and probably anatomical characters separating them may be distinguished. It is remarkable that such a small island as Norfolk Island should provide so many species of conical Zonitoids.

Genus Fanulena, *nov.*

Type, *Helix insculpta,* Reeve.

Shell small, conical, elevated, base flattened, columella toothed, mouth subquadrate, lip thin, sculpture of radial ribs sometimes obsolete, apex smooth. Anatomy as by Suter as above noted. Radular formula 35.7.1.7.35.

Fanulena insculpta, Pfeiffer.

Helix insculpta Pfeiffer, Proc. Zool. Soc. (Lond.), 1845, p. 129, February, 1846. Locality unknown.

Helix insculpta Pfeiffer, Conch. Cab. (Mart. & Chemn.), ed. Kuster, Vol., p. xxx., figs. 15-18, 1848; p. 243, 1849. No locality.

Helix insculpta Reeve, Conch. Icon., Vol. vii., pl. 180, sp. & fig. 1236, June, 1854. No locality, ex Mus. Pfeiffer.

Helix insculpta Wiseman, Cat. Curiosities, South Sea Islands, p. 32, November, 1865. Norfolk Island (ex Brazier MS.).

Helix basiodon Morelet, Rev. Mag. Zool., 1866, p. 165, May, No. "Siam" error = Norfolk Island.

Medyla insculpta Suter, Proc. Mal. Soc. (Lond.), Vol. iii., p. 330, 1899. Anatomy.

Described without locality, it was recognised by Brazier, and localised as from Norfolk Island, in a pamphlet, issued in Sydney, entitled, "Catalogue of Curiosities from the South Sea Islands." Exhibited by Commodore Sir W. Wiseman, Bart., C.B., H.M.S. "Curaçoa," at the Diocesan Book Repository, Phillip Street, Sydney, November, 1865. Seven trays of mollusca are listed (the names as of Brazier MS. in a note) as *Hydrocaena* (taken from the stomach of a *Zosterops*) *Helix insculpta* (Pfr.), *Helix Alexandrea* Cox, *Diplommatina, Helix morti* (Cox), *Helix insculpta* and *Hydrocaena.* None of the larger shells are listed, and Brazier accompanied the "Curaçoa" on its cruise and collected largely.

A subfossil from Nepean Island was named *nepeanensis* on account of its smaller size, and a figure prepared, which is here reproduced, along with figures of *insculpta,* showing the variation from the heights and lowlands.

Fanulena testudo, Preston.

Fanulum testudo Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 527, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

This very beautiful shell was well described, and figures of the type are here presented: Alt., 4.5; diam. maj., 7.75; diam. min., 7 mm.

Fanulena perrugosa, *sp. nov.*

Shell small, tall, elevated, recalling *imitatrix,* with the apical whorls apparently smooth; the other whorls rounded, prominently ribbed, about twenty ribs seen on face, base rounded, periphery subkeeled, columella slightly thickened, not toothed. Breadth, 3.75 mm.; height, 4 mm.

Only two dead shells are available, labelled Norfolk Island, but certainly from some of Quintal's debris. They may not be congeneric with *insculpta,* but on account of the scanty material only a subgeneric name is proposed, *Parcolena,* which differs in size, roundness of whorls and base, and also larger rounder mouth, and with no peripheral pinching. It is possible that the apex has been sculptured, but it would not enter into the groups following with sculptured apices.

Genus Lutilodix, *nov.*

Type, *Medyla imitatrix,* Sykes.

Shell small, imperforate, conical, sides little convex, periphery sharply angled, base almost concave, mouth quadrangular, lip thin, columella smooth, sloping. Sculpture of strong, slanting ribs, the apex completely

radially striate, not differentiated from adult sculpture. When living, the shell is covered with mud, and when gently cleaned the mud is seen to be held by bristles which grow on the ridges. Of course, these are worn off dead shells, but were mentioned by Sykes.

While this species has a resemblance to *Fanulena,* it differs in the apical and columellar characters, as well as being hairbearing.

Lutilodix imitatrix, Sykes.

Medyla imitatrix Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 142, pl. xiii., figs. 1-2, October, 1900. Norfolk Island, under dead bark and leaves.

Alt., 5.5; diam. max., 5 mm. This form is easily separated in the field through its mud covering and erect form, but from among the many *insculpta* collected some half dozen were sorted out that are exceedingly interesting, and very difficult to classify without animal characters being studied. The apices of these shells are concentrically lirate, sometimes with radials present, and have the columella more or less toothed.

Genus Dolapex, *nov.*

Type, *Dolapex amiculus,* sp. nov.

Fanulena-like shell with apex of two whorls finely concentrically sculptured, adult sculpture strong, columella toothed. Faint radials can be discerned on the first whorl of the apex, and these become a little more prominent on the second, while the adult sculpture closes up and the concentric striae disappear.

Dolapex amiculus, *sp. nov.*

Specimen, sorted out from debris sent by H. C. Quintal from lower slopes of Mt. Pitt, is immature, measuring a little over 5 mm. in breadth and 4 mm. in height, with two and a half adult whorls, these being sculptured with sharp slanting lamellae, one hundred on last whorl, interstices narrow, smooth. Base a little convex and pinched below the sharply-keeled periphery. The mouth broad, transverse, angulate, columella rather notably toothed, tooth white, the shell being brown, obscurely flamed with paler, almost white, radial stripes. Another immature shell from the same locality agrees generally, the apex being more finely concentrically striate, and radials obsolete, but a third, larger and more elevated, has the columella toothing less defined, the base more convex, the radials more distant and less sharp while the apex is more coarsely concentrically striate and the radials are finer and closer together. This may prove to be very distinct, so is here named *Dolapex fraternus,* sp. nov., the size being over 6 mm. in breadth by 5 mm. in height, the coloration being brown, rather strongly flamed with paler. This may be from a different locality on Mt. Pitt.

Genus Roybellia, Preston.

Roybellia Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 526, December 1, 1913. Orthotype, *Trochonanina platysoma,* Sykes.

Defined thus: "Shell very depressed, thin, horny, yellowish brown, transversely costulate, strongly and acutely carinate at the periphery, the termination of the costulae projecting beyond the margin of the carina."

Superficially this would be regarded as a degenerate flattened derivative of the *Fanulena* stock, but anatomical investigation might decide otherwise.

ROYBELLIA PLATYSOMA, Sykes.

Trochonanina platysoma Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 140, pl. xiii., figs. 16, 17, October, 1900. Norfolk Island, on and under dead leaves.

Measurements: Alt. 2.5; diam. max., 7.5 mm. This shell is so delicate that many specimens are broken, and through this it was discovered that the species is viviparous. The type locality would be the Lowlands, the lower slopes of Mt. Pitt. The succeeding species was found on the higher parts of Mt. Pitt.

ROYBELLIA DEPRESSA, Preston.

Roybellia depressa Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 526, December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

This unexpected second species is well described and its dimensions are: Alt., 1.5; diam. maj., 6.5 (nearly); diam. min., 5.5 mm.

Family ADVENIDAE.

This name is used for the beautiful shell called *Helix campbellii* Gray, as there is so little in Baker's scheme to fall back upon. The sculpture recalls that of *Irenella* Gude, introduced a little earlier for the Fijian *nouleti*. The anatomy of *Advena* has been studied by Semper (Reise Philippinen, Thl. ii., Bd. iii., p. 40, pl. iii., fig. 25, pl. vii., fig. 2, 1870), but this may be ignored by Baker, as he wrote: "The author of *'Aulacopus'* need not even be mentioned." It may be noted that this author, Pfeiffer, provided an anatomical study of the group!!

Genus ADVENA, Gude.

Advena Gude, Proc. Mal. Soc. (Lond.), Vol. x., p. 391, September 22, 1913. Orthotype, *Helix campbelli,* Gray.

Gude wrote: "Shell depressed, conoid, imperforate; whorls increasing rapidly, planate above, tumid below, keeled at the periphery, coarsely and unevenly ribbed or wrinkled above, the earlier ones with the ribs decussated by about six spiral sulci, which gradually become lost or indistinct on the later whorls, the decussation descending below the periphery and terminating rather abruptly, beyond which the base is smooth and polished."

ADVENA CAMPBELLII, Gray.

Helix campbellii Gray, Proc. Zool. Soc. (Lond.), 1834, p. 65, November. Phillip Island; collected by Allan Cunningham.

Helix campbellii Reeve, Conch. Icon., Vol. vii., pl. 82, fig. 438, March, 1852; pl. 127, fig. 765, December, 1852.

This is usually bicolor, the elevated conical spire fawn, the rounded base blackish. The shell has the columella straight, deflected over the umbilical cavity. The animal is viviparous, and the baby shells are subglobose, flat-topped, the first half-whorl smooth, the next one and a half with wrinkle sculpture, the base very convex, the columella with a very pronounced swelling. Dimensions, 8½ x 5½ lines. The typical shell was from Phillip Island and there is no series to test the insular variation, but Sykes noted: "Gray's specimen does not belong to the more usual form,

but has a white zone above the periphery." The type measurements read: $8\frac{1}{2}$ lines by $5\frac{1}{2}$ lines = 17 x 11 mm., and Reeve's figures are of the same size.

Preston named *Advena campbellii* var. *charon* (Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 526, December 1, 1913) from Mount Pitt, collected by R. Bell, on account of its uniform blackish brown colour, and this name may be used for the main island shell, which differs from the Phillip Island type as above noted.

ADVENA NEPEANENSIS, Preston.

Advena campbellii nepeanensis Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 527, December 1, 1913. Nepean Island, in subfossil condition only (R. Bell).

Described thus: "Shell much broader and with less elevated spire than has *A. campbellii* (Gray) from Norfolk and Phillip Islands. Alt., 15; diam. maj., 27; diam. min., 23.5 mm."

Genus MATHEWSOCONCHA, Preston.

Mathewsoconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 528, December 1, 1913. Orthotype, *Mathewsoconcha belli*, Preston.

Defined thus: "Shell imperforate, heliciform, depressedly turbinate, spirally striately sculptured, with thickened and inwardly bulging columella."

This genus includes the species allotted to *Fretum* by Sykes.

MATHEWSOCONCHA BELLI, Preston.

Mathewsoconcha belli Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 528. December 1, 1913. Mount Pitt, Norfolk Island (R. Bell).

Belloconcha norfolkensis Preston, *ibid.*, p. 530, Norfolk Island.

Dimensions: Alt., 6; diam. maj., 9.25; diam. min., 8.25 mm. Of *norfolkensis*: Dimensions: Alt., 6.5; diam. maj., 10; diam. min., 9 mm.

Figures of the type of *belli* are here given, but no figures were drawn of *norfolkensis*, when it was realised it was synonymous. Both were well described, so the identity is easily noted.

MATHEWSOCONCHA ALBOCINCTA, Preston.

Mathewsoconcha albocincta Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 528, December 1, 1913. Norfolk Island, subfossil in sand near the limestone quarry on the south-east coast (R. Bell).

Measurements: Alt., 5.5; diam. maj., 8.75; diam. min., 7.5 mm. Well described. Figures of the type are here presented.

MATHEWSOCONCHA VEXILLUM, Preston.

Mathewsoconcha vexillum Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 529, December 1, 1913. Limestone Quarry, Norfolk Island, in subfossil condition only (R. Bell).

Dimensions: Alt., 6.5; diam. maj., 9; diam. min., 8 mm. Figures of the type here given. Description good and sufficient.

MATHEWSOCONCHA MICROSTRIATA, Preston.

Fretum microstriatum Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 526, December 1, 1913. Norfolk Island, subfossil Limestone Quarry (R. Bell).

Measurements: Alt., 10; diam. maj., 16; diam. min., 14 mm. Figures of the type are here given, and the shell is well described, but, although Preston states "without trace of colour," some specimens show a white peripheral

band, contrasting against a dull yellowish, suggesting original colouring similar to that of *Mathewsoconcha belli,* while the columella features are those of *Mathewsoconcha.*

MATHEWSOCONCHA PHILLIPII, Preston.

Helix phillipii Gray, Proc. Zool. Soc. (Lond.), 1834, p. 65, November. Phillip Island, 5 miles south of Norfolk Island (Allan Cunningham).

Helix phillipii Reeve, Conch. Icon., Vol. vii., pl. 155, fig. 1443, December, 1854.

Measurements: 8 lines by 5 lines. Apparently only type series known.

MATHEWSOCONCHA SUTERI, Sykes.

Fretum suteri Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 140, pl. xiii., figs. 10, 11, October, 1900. Norfolk Island, ex H. Suter; coll. by R. S. Laing.

Measurements: Alt., 8.8; diam. max., 12 mm. Some specimens show spotting mentioned by Gray for the preceding species and commented upon by Sykes. Some notes on the crude anatomy of this species, by H. Suter, are given by Sykes, the jaw being oxygnathous, the animal viviparous, the foot has a parapodial and indistinct diagonal grooves; a caudal pore is present, and the sole is tripartite. The radula is figured (pl. xiii., fig. 19), and well described, the formula being 00-11-1-11-00, the 00 standing for about 100.

MATHEWSOCONCHA GRAYI, Sykes.

Fretum grayi Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 141, pl. xiii., figs. 6, 7, October, 1900. Norfolk Island (type locality), and Phillip Island.

Dimensions: Alt., 18; diam. max., 13.5 mm. Perhaps the Phillip Island shells are large *phillipii.*

Genus BELLOCONCHA, Preston.

Belloconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 529, December 1, 1913. Orthotype, *Belloconcha elevata,* Preston.

Defined as: "Shell imperforate, heliciform, turbinately conic, marked only with transverse growth-plicae." These may only be elevated species of the preceding genus, but there is no certainty yet.

BELLOCONCHA ELEVATA, Preston.

Belloconcha elevata Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 529, December 1, 1913. Nepean Island, in subfossil state only (R. Bell).

Measurements: Alt., 11; diam. maj., 14.75; diam. min., 12.75 mm. Figures of the type here given, the chief differential feature being the non-bulging columella.

BELLOCONCHA COMPACTA, Preston.

Belloconcha compacta Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 530, December 1, 1913. Nepean Island, in subfossil state only.

Measurements: Alt., 6.5; diam. maj., 10; diam. min., 9 mm. Well described and figures of the type are here presented.

Genus QUINTALIA, Preston.

Quintalia Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 527, December 1, 1913. Orthotype, *Caracolla stoddartii,* Gray.

Defined thus: "Shell imperforate, turbinately conic, minutely spirally striate, angled at the periphery." This intriguing shell was described under the genus *Caracolla,* was placed under *Helix* for many years, then trans-

ferred to the Neozelanic genus *Carthaea,* and later settled as above. Its relationship is still however very obscure.

QUINTALIA STODDARTII, Gray.

Caracolla stoddartii Gray, Proc. Zool. Soc. (Lond.), 1834, p. 65, November. Phillip Island, 5 miles south of Norfolk Island (Allan Cunningham).

Helix stoddarti Reeve, Conch. Icon., Vol. vii., pl. 206, fig. 1451, December, 1854.

The measurements given are: 7 lines by 4 lines; that is: breadth, 14 mm.; height 8 mm.; but some specimens were larger.

QUINTALIA FLOSCULUS, Cox.

Carthaea flosculus Pilsbry, Man. Conch. (Tyron), Ser. 2, Vol. 8, p. 77, pl. 22, figs. 79-81, 1892.

Helix flosculus Cox, Proc. Zool. Soc. (Lond.), 1865, p. 695, April 24, 1866. Norfolk Island (Turner); Journ. de Conch., Vol. xiv., p. 48, January, 1866. Same.

Helix patescens Cox, Proc. Zool. Soc. (Lond.), 1870, p. 84, June 2. Norfolk Island.

Charopa (?) *patescens* Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 143, fig. iii., in text, p. 144, October, 1900.

A smaller shell, measuring 10 mm. by 6 mm., the type being .40 x .37 x .26; that is, greatest breadth, 10 mm.; less breadth, 9 mm.; height, 6.5 mm.

The small unidentified shell (*patescens*) is undoubtedly a juvenile of *flosculus,* which was collected at the same time with it.

QUINTALIA INTERMEDIA, Preston.

Quintalia stoddarti intermedia Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 528, December 1, 1913. Nepean Island, in subfossil state only (R. Bell).

Preston wrote: "Shell intermediate in form and size between *Caracolla stoddarti* Gray, from Phillip Island, and *Helix flosculus* Cox, from the mainland; though only found in a subfossil state, some specimens show vividly the subperipheral chestnut band, as well as traces of the transverse colour-blotches above the periphery. Alt., 8; diam. maj., 13; diam. min., 11.25 mm."

No living material was found on Nepean Island, although obviously there was once a large faunula, but the interesting item is the notable differentiation from mainland forms, probably more pronounced in the Phillip Island fauna, of which, unfortunately, there is little knowledge.

Family ZONITIDAE.

Some minute Zonitoid shells are here included, as they are umbilicate, and the larger form, *Macgillivrayella,* has even been regarded as the same as the shell known as *Hawaiia minusculus,* of which see below.

Genus JOHANNESOCONCHA, Preston.

Johannesoconcha Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 532, December 1, 1913. Orthotype, *Johannesoconcha multivolva,* Preston.

Preston wrote: "Shell minute, vitreous, turbinate, multispiral, umbilicate. For a series of very small 'vitreous' shells Preston proposed the above, and placed the genus in the Zonitidae; from the preceding these differ in their size, texture and in being umbilicate.

JOHANNESOCONCHA MULTIVOLVA, Preston.

Johannesoconcha multivolva Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 532, December 1, 1913. Norfolk Island, under dead leaves (Macgillivray).

"Shell minute, turbinate, thin, white, polished, shining; whorls 5, rather rapidly increasing, the last scarcely ascending in front, faintly marked with lines of growth; base of shell radiately striate; suture well impressed; umbilicus moderately wide, deep, well-like; labrum simple; aperture obliquely sublunate. Alt., .5; diam. maj., 1.25 mm."

JOHANNESOCONCHA PUSILLIOR, Preston.

Johannesoconcha pusillior Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 533, December 1, 1913. Norfolk Island.

Smaller size, more depressed form and less well-like umbilicus. Dimensions: Alt., .25; diam. maj., 1.25 (nearly) mm.

JOHANNESOCONCHA MINUSCULA, Preston.

Johannesoconcha minuscula Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 533, December 1, 1913. Limestone Quarry, subfossil, Norfolk Island (R. Bell).

Shell very minute. Alt., .25 mm.; diam. maj., 1 mm.

A number of these minutiae have been sorted out from various parts of the island, and it would be a study alone to determine the species and relationships. As they are found in the least settled portions they may be endemic.

Genus MACGILLIVRAYELLA, Preston.

Macgillivrayella Preston, Ann. Mag. Hist., Ser. 8, Vol. xii., p. 533, December 1, 1913. Orthotype, *Macgillivrayella crystallina,* Preston.

Defined: "Shell depressedly turbinate, small, vitreous, somewhat broadly perforate."

MACGILLIVRAYELLA CRYSTALLINA, Preston.

Macgillivrayella crystallina Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 533, December 1, 1913. Norfolk Island.

Dimensions: Alt., 1; diam. maj., 2.5; diam. min., 2.25 mm.

See Austr. Zool., Vol. 10, p. 325, 1944, for an account of a Lord Howe Island shell described as *H. unwini,* and regarded as an introduction from America. This genus and species appears to be involved in the medley, so that no new name is given to *Macgillivrayella,* which is invalid. Preston provided one in MS. and added three other species, but these are left for further investigation.

Family ?.

HELIX DEPSTA, COX.

Helix depsta Cox, Proc. Zool. Soc. (Lond.), 1870, p. 98, June 2. Norfolk Island.

Charopa ? depsta Sykes, Proc. Mal. Soc. (Lond.), Vol. iv., p. 1, fig. in text, October, 1900.

This species has not yet been recovered from the collections of R. Bell, and the sendings of H. C. Quintal. The excellent figure of the type given by Sykes, prepared by Hedley, should enable its recognition if re-found. It recalls the juvenile of *Trachiopsis,* even showing weakly grained sculpture.

Family HELICARIONIDAE.

An extraordinary form was described by Preston, but was not figured. As far as I recollect only one specimen was found.

Genus DENDROLAMELLARIA, Preston.

Dendrolamellaria Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 522, December 1, 1913. Orthotype, *D. mathewsi,* Preston.

"Shell vitriniform, transparent, with smooth apical whorls and minutely transversely striate last whorl. The genus, which is arboreal in its habits, resembles almost exactly in form the marine genus *Lamellaria.*"

DENDROLAMELLARIA MATHEWSI, Preston.

Dendrolamellaria mathewsi Preston, Ann. Mag. Nat. Hist., Ser. 8, Vol. xii., p. 522, December 1, 1913. Ball's Bay, Norfolk Island (R. Bell).

Measurements: Alt., 15.5; diam. maj., 18.75; diam. min., 14 mm. The excellent description will enable easy recognition, when re-found, and a study of the animal might provide some surprises.

Family DURGELLINIDAE.

Sykes described *Sitala macgillivrayi* (Proc. Mal. Soc. (Lond.), Vol. iv., p. 142, pl. xiii., fig. 3, October, 1900) from Norfolk Island, collected by Macgillivray. In this case there can be little doubt that an error of locality has occurred, as nothing like this has been found on this island.

CONCLUSIONS.

Nothing has been seen to alter the opinion that this faunula has its nearest relations in Fiji, and there is little or nothing in common with the faunula of Lord Howe Island. Perhaps the most striking fact in this connection is the proportion of Zonitoids to the rest of the Mollusca, being in the case of Norfolk Island almost half as many again, and in Lord Howe Island not much more than one-third. The detailed comparison prepared at the time of the collection of shells, and published in the Trans. New Zeal. Inst., Vol. 47, pp. 498-508, 1915, is worth re-reading in connection with this essay, as there is very little to correct or add. It may be noted that it was not considered in the preparation of this report, which was prepared independently.

EXPLANATION OF PLATES.

Plate ii.

Figs. 1,	View of Settlement at south of Norfolk Island.
,, 2.	Vegetation on Mount Pitt.
,, 3.	Norfolk Island Pines.
,, 4.	View of North Coast of Norfolk Island.

Plate iii.

Figs. 1,	*Duritropis albocarinata* Mousson.
,, 2,	*Palmatina coxi* H. Adams, from type of *norfolkensis* Preston.
,, 3,	*Palmatina belli* Preston, type.
,, 4,	*Spirancinea nepeanensis* Preston, type.
,, 5, 6, 7.	*Allenoconcha basispiralis* Preston, type.

Figs.	8, 9, 10.	*Allenoconcha belli* Preston, type.
„	11, 12, 13.	*Allenoconcha monspittensis* Preston, type.
„	14,	*Allenoconcha congener* Preston, type.
„	15, 16, 17.	*Allenoconcha perdepressa* Preston, type.
„	18, 19, 20.	*Allenoconcha* (?) *retinaculum* Preston, type.
„	21.	*Greenwoodoconcha castaneocincta sericea* Iredale, type.

Plate iv.

Figs.	1, 2,	*Greenwoodoconcha castaneocincta sericea* Iredale, type.
„	3, 4, 5.	*Greenwoodoconcha tomi* Preston, type.
„	6, 7, 8.	*Pittoconcha concinna* Preston, type.
„	9, 10,	*Fanulena insculpta* Pfeiffer.
„	11, 12, 13.	*Fanulena nepeanensis* Iredale, type.
„	14, 15, 16.	*Fanulena testudo* Preston, type.
„	17.	*Advena charon* Preston, type.

Plate v.

Figs.	1, 2, 3.	*Mathewsoconcha belli* Preston, type.
„	4, 5, 6.	*Mathewsoconcha vexillum* Preston, type.
„	7, 8, 9.	*Mathewsoconcha albocincta* Preston, type.
„	10, 11, 12.	*Mathewsoconcha microstriata* Preston, type.
„	13, 14, 15.	*Belloconcha elevata* Preston, type.
„	16, 17, 18.	*Quintalia intermedia* Preston, type.
„	19, 20, 21.	*Belloconcha compacta* Preston, type.

JULES VERREAUX.

By Tom Iredale.

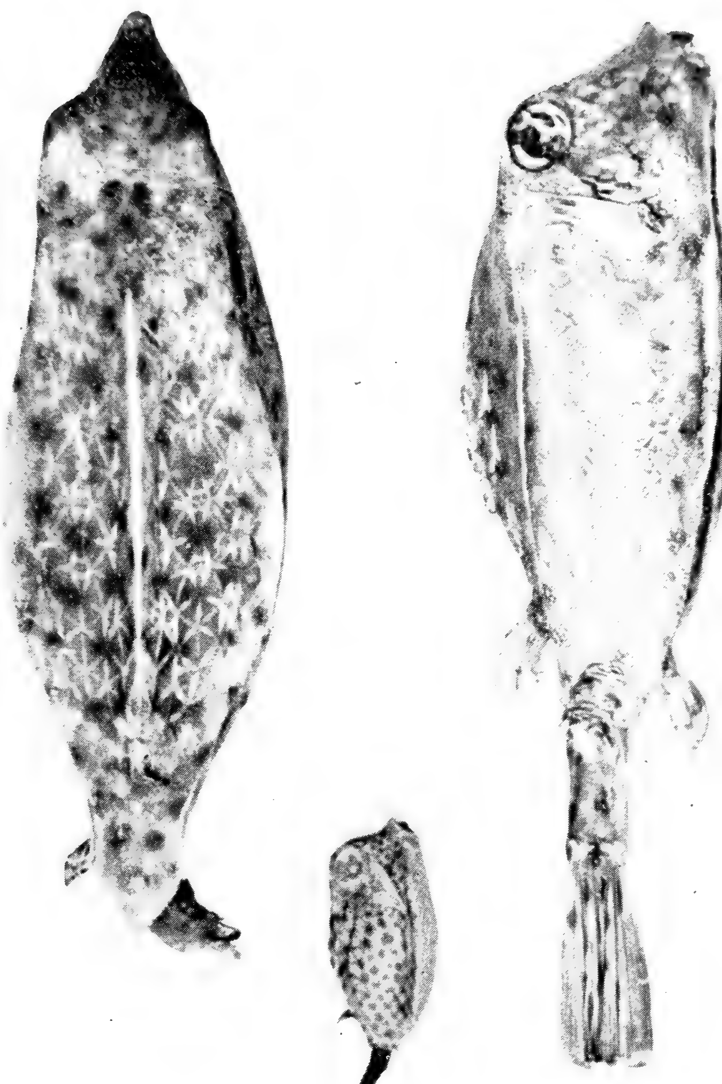
Little has been written about Jules Verreaux in connection with Australian ornithology, yet there may be something of great interest in the Paris Museum. It is certainly little known here that he spent some years in Tasmania and New South Wales in the pursuit of natural history on account of that museum. He came under my notice through a chance reference to a French Encyclopedia of Natural History, where a note was seen in connection with an Australian bird, referred to by Jules Verreaux from his "Zool. Tasman. et Austral. MSS." Then other notes were seen, and the date was given as 1844-45. A complete survey has not yet been made, and it is obvious that reference must be made to Paris to unravel the details. Thus the Encyclopedia was under the direction of Chenu, the bird part in collaboration with Des Murs. This bird part came out in six volumes and, according to the records, these appeared in the years 1853-54. The work appeared in parts of six to seven sheets—five parts to a volume. It is very popular, mostly figures with little text to begin and end with, and

was rather scathingly reviewed by Hartlaub, who mentioned "Als des Wethvollste des Textes erschienen uns *zahlreiches treffliche Originalnotizen der Brüder Verreaux nach ihren zoologischen Manuscripten über Australien und Africa.*"

The first volume contains no notes by Verreaux, although it treats of Parrots, Cuckoos, etc., but the second has good notes regarding *Dacelo, Podargus* and *Aegotheles.* In connection with the last-named reference is made to Jules Verreaux and his "Journal si précieux de son Voyage en Australie et en Tasmanie." The good account on *Podargus* had been published in the Revue Zool., for 1849, p. 59, in which Journal two other bird notes appear; one on *Orthonyx* in the Revue Zool., 1847, p. 241, and the other on *Menura* in Revue Zool., 1849, p. 113. Another note on the Animals of Tasmania appeared in the Revue Zool., 1848, p. 70, signed J.P.V. Other notes appear in Vols. iii., iv. and v. of the Encyclopedia, which will be detailed later, but apparently the work was getting out of hand, and Vol. vi. is like the first, simply numerous pictures, with a few lines of text, as, instance, the Emu is granted some half-dozen lines; hence there appears to be no time or place for Verreaux's notes on anything in this volume.

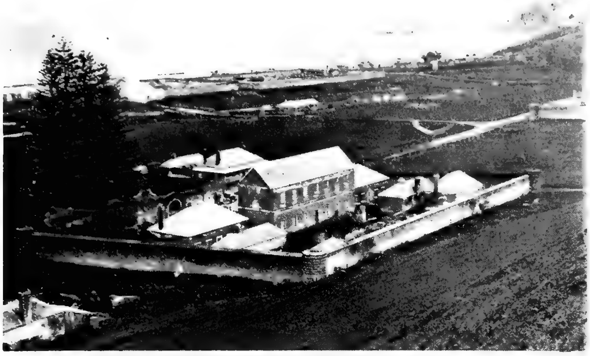
Then, who was Verreaux? He was one of three brothers who had been born with a love of Natural History, apparently the eldest, as he was born in 1807; a brother, Edouard, in 1810, and a third brother, Alexis, who died while collecting in South Africa. A curious entry was noted in connection with a Bird of Paradise in the "riche collection que J. Verreaux avait formée et possedait en 1823," and it seemed to refer to another J. Verreaux, until it was discovered that he accompanied his uncle, Delalande, another famous naturalist, to South Africa in 1818! While Jules was at the Paris Museum, the brother Edouard carried on a business in Paris, the Maison E. Verreaux, which was famed for some twenty-five years.

Sharpe, in the History of the Collections Nat. Hist. British Museum, Vol. ii., p. 503, 1906, wrote: "He (Jules) possessed an immense knowledge of birds, probably greater than any man of his generation." (p. 340.) "Jules Verreaux, who came to England when the German army approached Paris, in 1870, was received by the English ornithologists with great sympathy, and lived for some three weeks in my house." It may be put on record here that a little book was issued in 1863 listing the Ornithological Collection of Baron de Lafrenaye, a small octavo of 258 pages, listing 8,656 specimens. It is lithographed, and little known and of comparatively little value. Hartlaub mentions that this was prepared by Jules Verreaux, and it comes in the limelight through the fact that this little insignificant work became the basis of G. R. Gray's Handlist of the Genera and Species of Birds, issued in three volumes, from 1869-1871, the most important work of its kind. Gray took the Lafrenaye List and had it interleaved, adding eighty blank pages, and then added all the species and synonyms, working it up in his careful and well-known systematic manner. Gray's first choice was Catalogue of Species of Birds, then Handbook, and after he had transferred the matter into better form selected Handlist. It is interesting to note that this appeared before Verreaux's death in 1873. Musgrave's excellent Bibliography of Australian Entomology, p. 333, 1932, gives all the general references necessary, but this invaluable work is not as commonly referred to by ornithologists as it deserves to be. This is merely a preliminary note to draw attention to this overlooked student of Australian ornithology.



Boxfish, *Rhynchostracion nasus* (Bloch). Dorsal view of a Broome specimen, lateral view of a Shark's Bay example, and a young specimen from Broome.

Photograph by S. Fowler.



The old Settlement at Kingston.

Characteristic undergrowth.

North Coast.

Araucaria Forest.

Norfolk Island Views.

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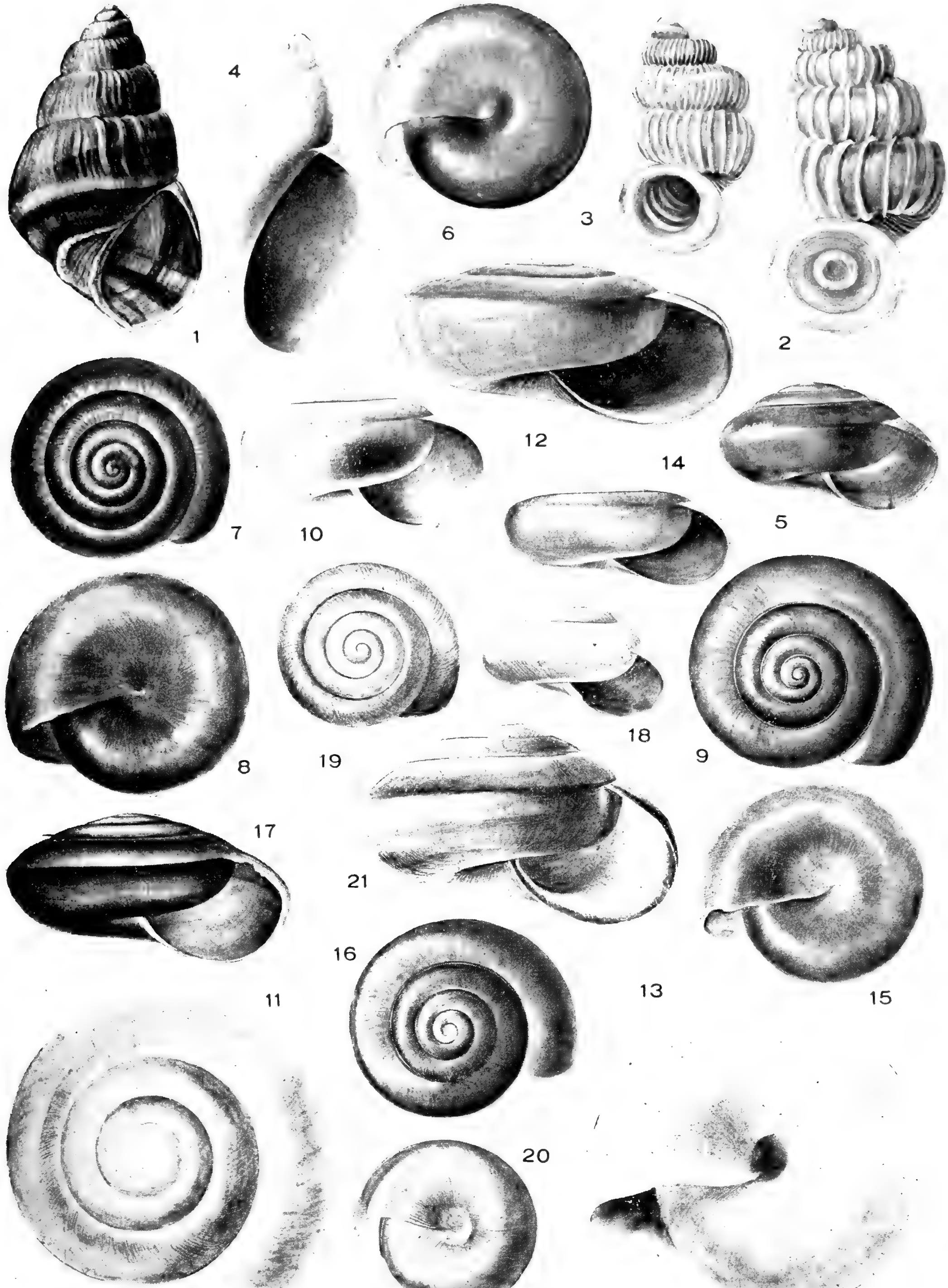
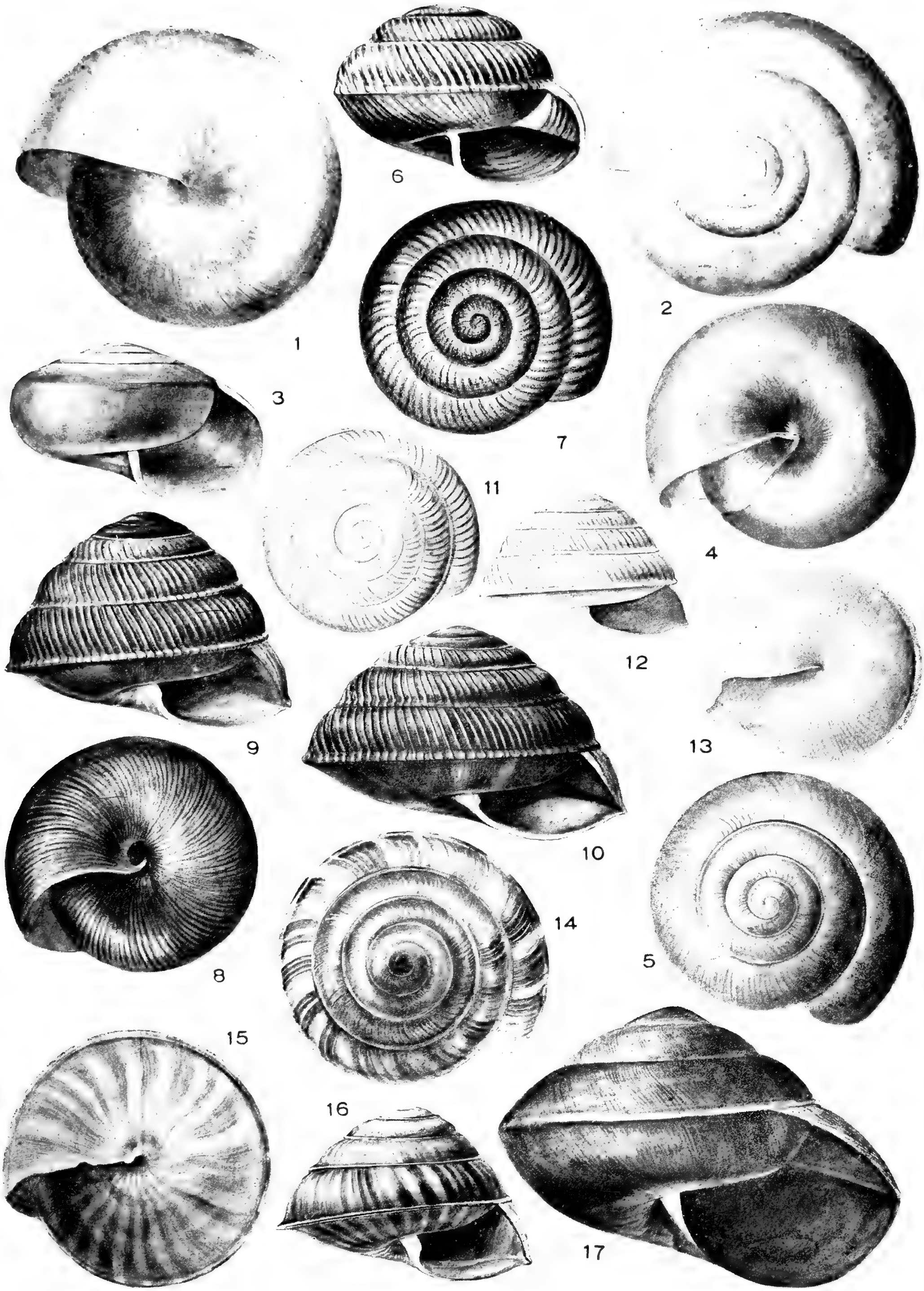


Land Mollusca of Norfolk Island.

Roland Green, del.



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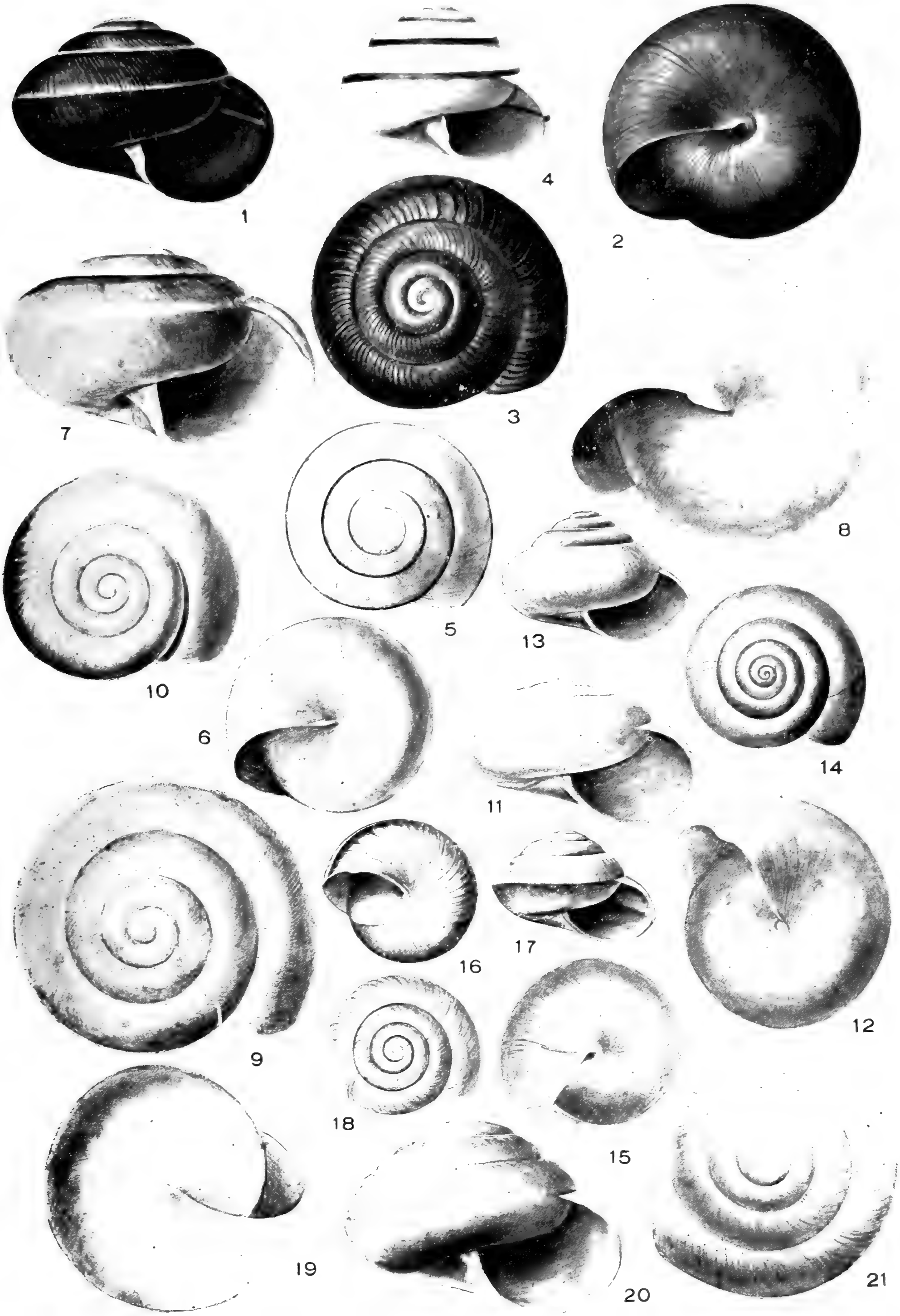

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THE GENUS *MESOPLODON* IN WESTERN AUSTRALIAN SEAS.

By L. Glauert.

(*By permission of the Trustees of the Public Library, Museum and Art Gallery of W.A.*)

(Plate vi.)

Every year Cetaceans are washed up on Western Australian beaches. Many of these belong to species whose presence in these waters has long been known, but now and again individuals are found which represent additions to the State's faunal list. Two of these are the subject of this contribution. The strandings were reported to Head Office by the district Fisheries Inspectors, and the heads duly forwarded to the Museum through the good offices of the Chief Inspector, Mr. A. J. Fraser.

The assistance given by the Chief Inspector on so many occasions and the interest shown by the members of his staff have been invaluable and are duly acknowledged.

Mesoplodon grayi v. Haast, 1876. *Southern Beaked Whale.*

(Plate vi., figs. 1 and 3.)

In June, 1940, Fisheries Inspector M. Goodlad, of Bunbury, reported that a small whale had been washed ashore. It had evidently been dead for some time as most of the black skin had peeled off the back. From his examination he concluded that it was a Beaked Whale.

The Chief Inspector at once got in touch with the Museum and, as it was impossible owing to war conditions to preserve the skeleton, arranged with Inspector Goodlad to have the head forwarded to the Museum.

The following information was supplied by Inspector Goodlad: "Sex, male; length, 14 ft.; mouth from tip of jaw, 15 inches; mouth to eye, 12 inches. Blow-hole directly above the eye. Flipper about 4 ft. from the tip of the snout, and 18 inches long, measured along the forward edge. Tail 50 inches across the flukes. Tooth protruding half an inch and 3 inches along the jaw."

After the skull had been cleaned it was found that the animal was a *Mesoplodon grayi* v. Haast. The whale was evidently an old male, the rostrum being fully ossified and the teeth worn down almost to the gums. No traces of vestigial teeth were found.

The principal skull measurements are as follows: Length, 828 mm.; breadth at squamosals, 309; breadth at orbits, 277; height, 260; length of rostrum, 547; length of mandible, 687; length of symphysis, 225; length of tooth, 70 mm.

Forbes having shown that the species is very variable, the dimensions

and proportions varying with sex and age, this specimen, M.2439, may be regarded as a typical example of the species. See also O. Abel, in Kultur der gegenwart, Part III., Section IV., Vol. 4, p. 381 (1914).

MESOPLODON BOWDOINI Andrews. *Andrews' Beaked Whale.*

(Plate vi., figs. 2 and 4.)

In April, 1944, Fisheries Inspector J. Goodlad, who had taken his brother's place at Bunbury, reported the presence of another Beaked Whale and at my request secured the head for the Museum. This proved to be of exceptional interest, as it is the first record of the presence of the rare New Zealand *Mesoplodon bowdoini* Andrews in Australian waters. The detailed measurements show how closely it agrees with the two known specimens in the American Museum of Natural History, New York, and the Dominion Museum, Wellington, respectively, with which it is evidently conspecific. Registered No. M.2617.

DESCRIPTION.

An almost complete skull and mandible with one of the slender zygomatic processes of the malar missing. An adult animal, with the rostrum almost completely ossified, except at the extreme tip; teeth partly worn; many of the sutures closed and condyles smooth, not pitted.

Basirostral groove absent; rostrum much expanded laterally at the base owing to the development of the maxillae; premaxillary foramina behind the maxillary foramina; antorbital notches divided, and premaxillae completely overhanging the nares.

Edges of the maxillae overlying the orbital processes of the frontals much thickened, forming two prominent ridges, which curve inwards to the maxillary tuberosities. Proximal ends of the premaxillae strongly everted and overhanging the nares; both directed obliquely backwards, the right 123 mm., the left 81 mm. long.

Right nasal bone forming the vertex; the left lower and smaller; the former with a deep sinus running across it transversely and ending in a vertical foramen between it and the maxilla; sinus on the left smaller and less distinct.

A small projection of the flattened and expanded anterior end of the malar just visible in the bottom of the outer (real) antorbital notch. Zygomatic processes of the squamosals extend far forward and are overlapped by the postorbital processes of the frontals. Temporal fossa pyriform, slightly above the level of the occipital condyles.

Rostrum ossified almost to the tip; its general outline as figured by Andrews and Oliver. A strong median ridge on the proximal third below flanked by a groove about 50 mm. long. Palatines completely surrounding the pterygoids anteriorly, separating them from the maxillaries. The external strip varies from 25 mm. to 30 mm. in width; the inner tapers from 15 mm. anteriorly to an obtuse point at the junction of the pterygoids in the middle line. The pterygoids and maxillaries are in contact in both the New York and the Wellington specimens, thus showing a difference which is, however, of little taxonomic importance, as Forbes found when dealing with a long series of *M. grayi* that the palatines may be outside the pterygoids, not reaching their tips, or may completely surround the tips of the pterygoids, so preventing their coming in contact with the maxillaries.

The mandible agrees fairly closely with Andrews' description and figures (p. 207 and figs. 2 and 3), but the teeth being smaller the jaw is less massive at the alveoli. The teeth are slightly worn; the tip of the right still present; anteriorly, probably slightly concave when unworn; posteriorly very convex; laterally compressed.

Measurements in Millimetres.

Skull.

	length	breadth at squamosal	breadth at orbits	height	rostrum	height at pterygoids
W.A.M.	728	342	328	311	425	86
N.Y.	715	335	325	311	428	—
N.Z.	720	330	318	302	435	82

	occipital condyles	foramen magnum	temporal fossae
W.A.M.	70 x 40	48 x 37	120 x 73
N.Y.	—	—	120 x 80
N.Z.	70 x 42	50 x 40	95 x 65

Mandible.

	length	length of symphysis	posterior depth	depth behind tooth	distance from alveolus to condyle	length of tooth
W.A.M.	621	113	128	66 & 68	405	64 & 67
N.Y.	628	146	127	65	395	75
N.Z.	630	150	125	70	—	110

References:

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Forbes, H. O.—"Observations on the Development of the Rostrum in the Cetacean genus Mesoplodon with remarks on some of the species." *Proceedings of the Zoological Society of London*, 1893, p. 216, pls. xii.-xv. and 2 t.f.

Haast, J. von.—"On a New Ziphioid Whale." *Proceedings of the Zoological Society of London*, 1876, p. 7.

Harmer, S. F.—"On Mesoplodon and other Beaked Whales." *Proceedings of the Zoological Society of London*, 1924. Remarks on p. 544.

Oliver, W. R. B.—"A Review of the Cetacea of New Zealand, Part I." *Proceedings of the Zoological Society of London*, 1922, p. 557, pls. i.-iv.

EXPLANATION OF PLATE VI.

(Figures, from uppermost downwards.)

1. Skull of Southern Beaked Whale.
2. Skull of Andrews' Beaked Whale.
3. Lower jaw of Southern Beaked Whale.
4. Lower jaw of Andrews' Beaked Whale.

BIOLOGY AND TAXONOMY OF THE SOLITARY BEE, *PARASPHECODES FULVIVENTRIS* (FRIESE).

By Tarlton Rayment, F.R.Z.S.

(Plates vii.-x., text-figs. 1-5.)

Introduction.

It has been evident to the author for many years that the generations of certain species are linked in some remarkable way with the cycles of the seasons. This concept was born after a study of the spectacular migrations of a number of animals, for it is certain that the presence of extraordinarily large numbers of animals connotes a superabundance of food and, since a number of herbivorous species are involved, plant-life must be the determining factor.

Since plants are the products of their ecology, it follows naturally that a superabundance of a species connotes favourable conditions for their development. Plant-life is so dependent on moisture that prolific growth is inevitably associated with ample rainfall.

The critical study of the biology of a species over a long period would assuredly also provide a key to the cycle of the seasons in a given locality. The species observed by the author are in several Orders, the emu (*Dromaius*); cockatoo (*Calyptorhynchus* sp.); capeweed (*Cryptostemma calendulaceum*); cypress-pine (*Callitris* sp.); gum-trees (*Eucalyptus* sp.); wattles (*Acacia* sp.); camel weed (*Teucrium* sp.); and many of the indigenous bees, all of which experience a period of superabundance followed by a recurrence of scarcity.

Certain wild-bees are exceedingly numerous in "good" years—that is, when an ample rainfall has produced a prolific growth of flowers. Since the eggs which developed the vastly increased numbers of bees were deposited 12 months previously, then some factor must have been operating at that period to bring about such a result. This is all the more remarkable when one remembers that not a single mother bee survives from one season to the next. The student finds it easy to postulate that the solitary mothers have some prescience of the nature of the ensuing season.

The indigenous bees are pre-eminently suitable for this research because they have been evolved together with the native flora and, therefore, are perfectly adapted to their ecology. Conversely, the introduced honey-bee, *Apis*, is almost valueless in this study, not only because of its unnatural concentration by man in large commercial apiaries, but also because of the fact that it is foreign to the flora, and, therefore, not adjusted to the ecology in which it now finds itself as the result of man's interference.

This maladjustment was observed in 1942, in New South Wales, when the author demonstrated conclusively that the many thousands of colonies of bees which were lost in the large commercial apiaries had died from a "deficiency" disease (malnutrition), brought about by one of the periodic failures of the white-box, *Eucalyptus albens*, to mature its male cells or pollen-granules, thus leaving the honey-bees without a supply of protein,

although there was an abundance of hydrocarbons (honey).—Rayment—in the press.

As part of the endeavour to find the "key" to the cycle of the seasons, the author investigated the biology of an exceedingly large "colony" of a solitary bee, *Parasphecodes fulviventris* (Friese), and as the life-history of any species in this genus was hitherto unknown, the author trusts that that will justify the publication of this paper. The taxonomic details have been forced upon the author by the circumstances.

The author is indebted to H. Womersley, F.R.E.S., of the Adelaide Museum, for his identification of the Collembolan specimens. The research was assisted by a small grant by the Trustees of the Commonwealth Science and Industry Endowment Fund, but the exigencies of war delayed the publication for several years.

Taxonomic Position.

Division ANDRENIFORMES.
Family ANDRENIDAE.
Subfamily HALICTINAE.
Genus PARASPHECODES Smith.
(Catalogue Hym., B.M. i., p. 39, 1853.)
Species *Halictus fulviventris* Friese.
Allgemeine Betrachtungen über die Bienenfauna Australiens, pp. 1-9, 1917.
Parasphecodes fulviventris Cockerell.
American Museum Novitates, No. 343, p. 16, March, 1929.

Gross morphology.

Although Smith observed that these bees have a superficial resemblance to the European red-bodied *Sphecodes,* a parasitic genus, the author's investigations prove that *Parasphecodes* are industrious bees closely related to *Halictus.* The females have a rima or furrow on the apex of the abdomen, and most, if not all, of the males have a yellow mark on the clypeus; both characters being typical of *Halictus.* The glossa is short but acute in both sexes; there are four segments in the labial, and six in the maxillary palpi, as in *Halictus.*

The inclosed area of the metathorax exhibits even stronger rugae than *Halictus,* which sometimes has this sculpture quite weak, as in the *H. bicingulatus* group.

As Professor Cockerell, 1932, has observed, although the great majority of the species has a red abdomen, yet there is a series entirely black, and which are extremely difficult to separate generically from *Halictus.* However, Cockerell, 1930, proposed the subgenus *Aphalictus* for two species, *P. bribiensis* Ckll., and *P. bribiensiformis* Ckll., the females of which have bosses on the first two tergites.

The wing neuration was studied in an exceedingly large series, and it exhibits the variations found in so many other bees. This generic character of Smith, therefore, may be disregarded. The genus was revised by Reinhold Meyer, 1920, but he had too few specimens to be adequate for the purpose. The author has a comprehensive collection, and he agrees with Cockerell, that *Parasphecodes* is extremely close to *Halictus,* but since he has found some divergence in the biology, it is better to retain the genus.

Almost confined to the eastern States of Australia, the genus is comprised of bees rarely more than 10 mm. in length. The males are smaller,

with longer antennae, and the labrum of the female has the triangular appendage characteristic of *Halictus*. The scopa of the female tibia is denser than that of *Halictus* and, generally, there is a larger number of hamuli on the posterior wing. The calcar of the female's hind tibia lacks the coarse teeth of *Halictus*, and the strigil of the anterior tibia exhibits no distinctive character, being almost identical in form with that of *Halictus*.

There are five species bearing a tubercle on the second sternite, and it is difficult to separate them by the descriptions, and, even when the specimens are before the student, the task is not easy, for the group demands critical study for accurate determination. The task was complicated by the presence of two species in the one great aggregation of "nests," *P. fulviventris* (Friese) and *P. arciferus* Ckll. The following synopsis will help students, and the specific descriptions of two allotypes are appended. All the males have, of course, a yellow clypeal mark. It is possible that *P. leptospermi* is the female of *P. hybodinus*.

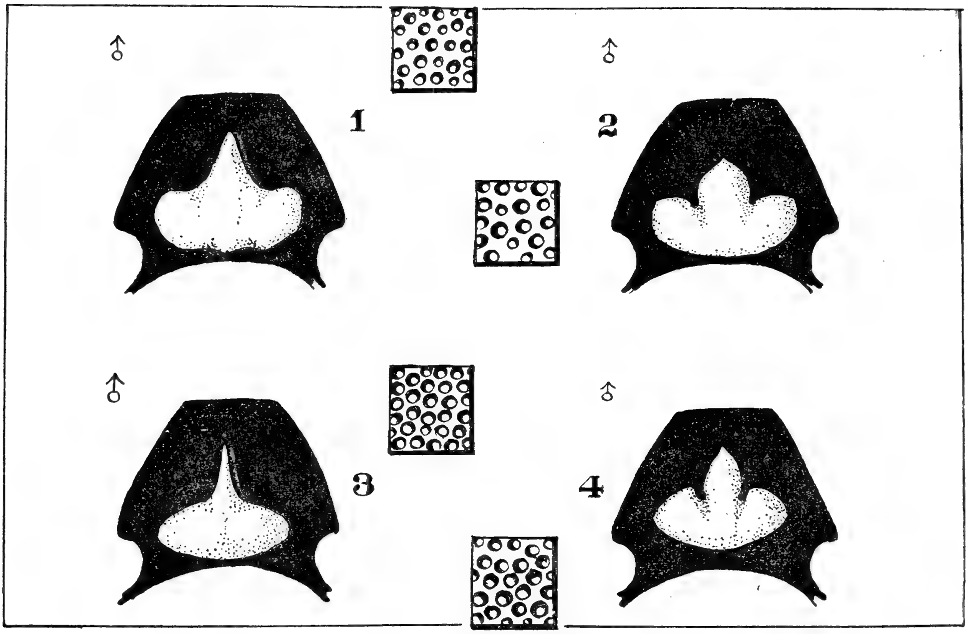


Fig. 1.—Clypeal marks and puncturation of the scutellum of males.
1. *P. fulviventris* (Fr.).
2. *P. anhybodinus* Ckll.
3. *P. arciferus* Ckll.
4. *P. hybodinus* Ckll.

There is a subspecies of *P. fulviventris*, with a bi-gibbose dull scutellum, and a minute tubercle; tergite one having no black basally; and tegulae polished black; hair of vertex and thoracic disc mixed black and white; second cubital cell higher than wide; nervures dark-amber, and pterostigma amber with a darker margin. This might be known as *P. fulvi-*

ventris proximus, subsp. nov. Collected by the author at Sandringham, Victoria, October, 1942.

Parasphecodes fulviventris (Friese).

Allotype, male: Length, 8 mm. approximately. Black and red.

Head long, with white hair on face; frons rugoso-punctate; clypeus shining, convex, an oval yellow mark with a small upward point; supraclypeal area shining, coarsely punctured like the clypeus; vertex with blackish hair; compound eyes reniform, converging strongly below; genae rough, with a few long white hairs; labrum black; mandibulae black, reddish apically; antennae obscurely reddish beneath.

Prothorax not visible from above; tubercles heavily fringed with white hair; mesothorax bright, closely and coarsely punctured, but shining between, with blackish hair; scutellum similar; postscutellum rough, with white hair; metathorax with coarse radiating rugae, abdominal dorsal segments 1 and 2 with a fulvous band; 3 suffused with reddish; 1 and 2 closely punctured; ventral segments coarsely punctured, more or less banded fulvous and black.

Legs brown, with white hair; tarsi similar; claws reddish; hind calcar amber; tegulae brown, closely punctured; wings slightly dusky-yellow; nervures sepia; second cubital cell almost square; pterostigma sepia; hamuli ten.

Locality: Sandringham, Victoria, September 18, 1932 (Rayment).

Allotype in the collection of the author.

Allies: Taken in copula. The male is the smallest of the group.

Parasphecodes anhybodinus Ckll.

Allotype, female: Length, 10 mm. approximately. Black and red.

Head broad, with scanty white hair; frons rugoso-punctate, but shining; clypeus polished; scattered large punctures, a depressed median line; supraclypeal area elevated, with close puncturing; vertex with some black hair; compound eyes reniform, converging below; genae with long white plumose hair; labrum and mandibulae black; antennae black.

Prothorax with short moss-like white hair; tubercles polished, heavily fringed with white hair; mesothorax rugoso-punctate; coarse; with blackish hair on disc; pleura coarsely rugose; scutellum coarsely punctured, with black hair, like the mesothorax, bi-gibbous; postscutellum with black and white hair; metathorax with coarse radiating wrinkled rugae; abdominal dorsal segments 1-2-3 very deep-red; 1 more closely punctured; 3 deeply suffused; others shining black; ventral segments with reddish-suffusion on 1-2-3; with large blackish tubercle on sternite.

Legs blackish-brown, with white hair showing a dusky line; tarsi brownish, white hair; claws reddish; hind calcar pale-amber; tegulae black, polished, coarsely punctured; wings dusky apically; nervures brownish; second cubital cell very long; pterostigma brownish; hamuli thirteen, strongly developed.

Locality: Sandringham, Victoria, October 10, 1941 (Rayment).

Allotype in the collection of the author.

Taken in copula.

Synopsis of Characters of the Females.

P. fulviventris (Friese).

Length, 10-11 mm. approximately. Clypeus with a median sulcus; scutellum with punctures smaller than those of the mesothorax; area of metathorax with strong rugae; little if any black on basal tergite; legs with white scopa; wings dark; pterostigma dark-brown; second intercubitus meets first recurrent nervure; large tubercle on sternite.

Melbourne; Sandringham, Victoria (Rayment).

P. arciferus Ckll.

Length, 9 mm. approximately. Clypeus with a median depression; scutellum with scattered large and small punctures, shining; area of metathorax with strong oblique rugae; a black patch on basal tergite; legs with brown scopa; wings paler; stigma dark-amber; second intercubitus just beyond the first recurrent nervure. Small tubercle on sternite.

Mordialloc; Sandringham, Victoria (Rayment).

P. anhybodinus Ckll.

Length, 10 mm. approximately. Clypeus with a depressed median line; scutellum with large punctures closely spaced, shining; area of metathorax with well-marked oblique rugae; black area on basal tergite; legs with smoky scopa; wings dark apically; stigma amber with dark margin; intercubitus just beyond the first recurrent nervure; second cubital cell large; small tubercle on sternite.

Cheltenham; Sandringham, Victoria (Rayment).

P. hybodinus Ckll.

Length, 10 mm. approximately. Clypeus depressed; scutellum with coarse punctures, shining; area of metathorax with large oblique rugae; black area on basal tergite; legs with whitish hair; wings dark apically; pterostigma dark-amber; second intercubitus meeting first recurrent. Large tubercle on sternite.

Windsor, Cranbourne, Sandringham, Victoria (Rayment).

P. leptospermi Ckll.

Length, 10 mm. approximately. Clypeus with scattered punctures, shining; scutellum bi-gibbous, shining, sparse punctures; area of metathorax with weak irregular rugae; tergites 1 and 2 red; legs with smoky hair; wings dusky apically; pterostigma dark-sepia; second cubital cell large; first recurrent almost meeting second intercubitus; tubercle on sternite large.

Brisbane, Queensland (Rayment).

Locality.

An immense colony of *P. fulviventris* was discovered in the eastern bank, some 25 ft. in height, along the railway from Hampton to Sandringham, 10¾ miles from Melbourne. Since the line runs approximately north and south at this particular section, the eastern bank receives the full brunt of the afternoon sun, and is, therefore, a sheltered and warm situation, whilst its height ensures adequate drainage.

Site of the Nest.

It is the second largest colony of bees reported in the literature of the Apoidea, and is exceeded in area only by one, reported by Rica Erickson, 1941, of Bolgart, Western Australia. This observer described a wheat-field, a great many acres in extent, and which was perforated closely with the shafts and the shallow galleries of a small black bee. The author received specimens from this correspondent, and determined them as *Paracolletes pusillus* Ckll.

The area occupied by *Parasphecodes fulviventris* measured 600 ft. approximately in length. Owing to the steep angle of the bank, and the frequent passage of fast electric trains, it is impracticable to study critically the entire "face," which contains an enormous number of shafts. Since the geological strata vary with the height, there are fewer shafts on the "face" than on a narrow line, some 10 or so feet in width, along the flattish top, where the sandy loam is consistent throughout its entire length.

It was found, by actual count, that along the top the shafts averaged 30 to the square yard. Of this number 12 had tumuli of new damp sand during the month of February. The remaining 18 usually had the friable sand beaten down level, either by the wind, or the rain, so that the entrances to the shafts were just mere holes at ground level. In a "lean" year there was an average of only 12 shafts to the square yard.

Geology of District.

This is the well known "old red sand" formation (Tertiary) of the eastern shore of Port Phillip. At sea level is the reddish-brown rock, on which rests from 20 to 30 ft. of creamy-coloured decomposing sandstone known locally as "marl," and on top of all is the greyish sandy loam so characteristic of this area. In places, the yellow sand extends down for several feet, probably deposited as dunes, but generally it is from two to three feet in depth.

The bees appear to favour the even consistency of the sandy loam, where excavation presents no great difficulty. This choice, therefore, is in sharp contrast to that of *Euryglossa fasciatella* Ckll., which confines itself exclusively to excavating in the hard dry marl exposed along the sea-cliffs (Rayment, 1927, 1935).

Although the shafts of *P. fulviventris* are close, yet they are sufficiently distant from each other not to intersect, and there is no torturous plan wherein the galleries are mixed in inextricable confusion, as in *Halictus emeraldensis* (Rayment, 1937), which digs in tough red volcanic loam.

The nests are in ground similar in every respect to that favoured by *Paracolletes facialis* Ckll., and *P. tuberculatus* Ckll., and colonies of both these bees were found in flat situations a hundred yards or so distant from the bank (Rayment, 1931).

Ecology.

The great difficulty experienced—the search extended over 20 years—in locating the shafts was due to the effective masking of the site by a dense growth of vegetation. Only when railway fettlers cleared the area, for a fire-break, was it possible to discern the shafts. The plants are characteristic of the Sandringham flora, the tallest being the tea-trees (*Leptospermum laevigatum* and *L. myrsinoides*); Nodding blue-bell

(*Dianella revoluta*); Heathy parrot-pea (*Dillwynia ericifolia*); Guinea flower (*Hibbertia stricta*); Club-rush (*Scirpus nodosus*); Pigface (*Mesembrianthemum* sp.); Small grass-tree (*Xanthorrhoea minor*); several small lilies; the introduced Flatweed (*Hypochaeris radicata*), and Capeweed (*Cryptostemma calendulaceum*) are growing closely together.

Architecture.

The tumuli seldom exceed three inches in height, with a basal diameter of three inches, but they differ a trifle from those of *Halictus*, which have a central crater, like a miniature volcano. *P. fulviventris* constructs a cowl very similar to that of a *Cerceris* wasp (Rayment, 1947). The entrance is seldom if ever in the centre of the mound, but is placed more or less to one side, and, since the shaft invariably goes down at an angle, the moundlet becomes a kind of hood, as with *Cerceris*. The opening is usually to the north, but a few are a few points off to the east or to the west.

The material brought up from below is invariably fine greyish sand, slightly damp at first, but it soon dries, and is quickly dispersed in a few hours if windy. Most of the digging is done at night, and early morning; up to about 10 o'clock is the best time to observe the moundlets. The worker does not show herself whilst disposing of the spoil, for she just thrusts it up from below without opening or destroying the tumulus.

Very rarely there is a conical moundlet with two entrances only 1½ inches apart, and the reason for this unusual structure is not clear, since the rule is one female to each shaft. In this they diverge widely from *Halictus emeraldensis*, and *Nomia*, where several females (sisters) use the same entrance (Rayment, 1943).

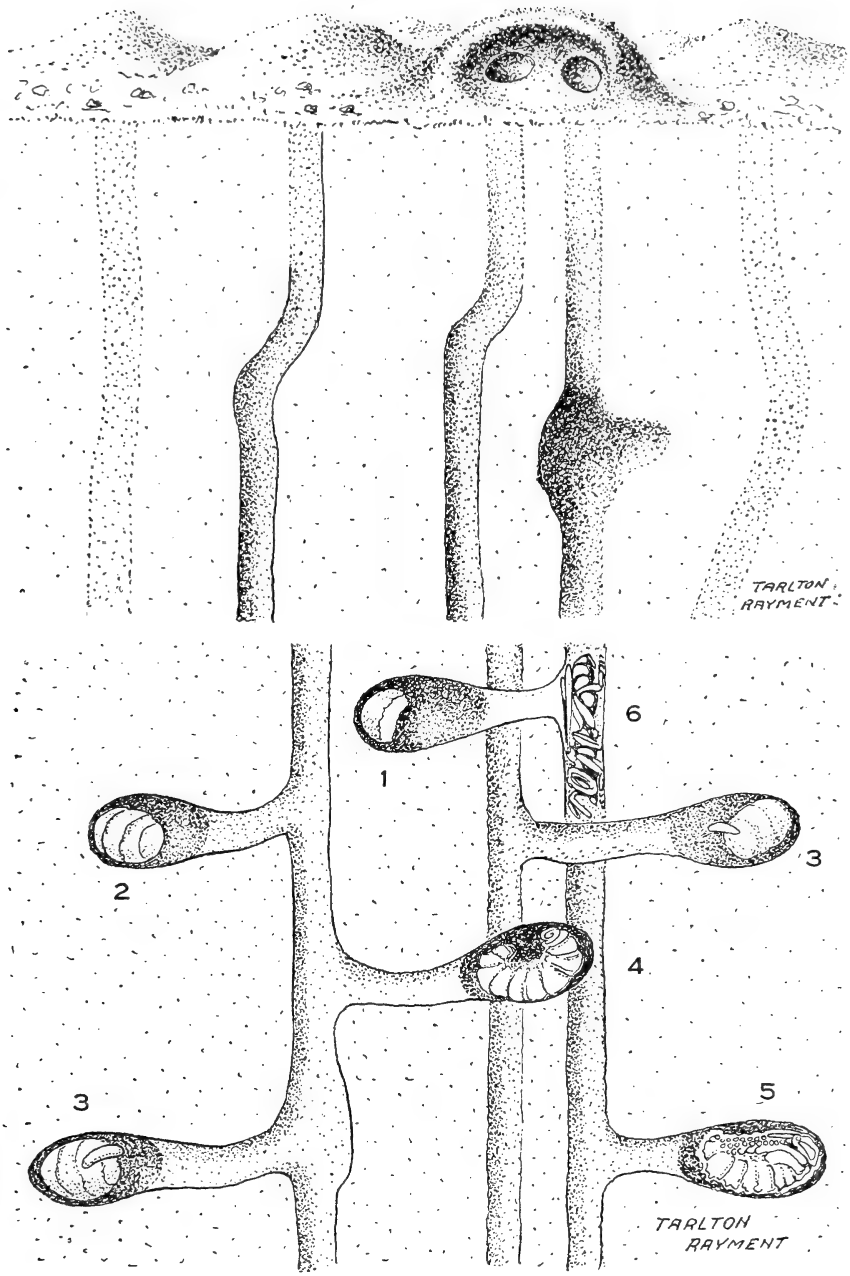
The shafts, with a diameter of 5-6 mm., go down at first at an angle of 45 deg., or thereabouts, for approximately five inches, the angled portion being 10 inches in the longest, and the shortest one only about 2½ inches. The shafts then wind down more or less vertically for about 2 ft. From the main shafts are a number of short radiating galleries which end in single ovoid cells, and never in twin structures, as in *Cerceris*. The shafts take on a larger irregular diameter as they go deeper, as though they were extensions of original cells.

The great majority of the cells were discovered at about 2 ft. 6 in. from the surface. Generally, the upper 20 inches of sand are dry, and doubtless the bees go deeper to ensure the requisite humidity during the summer months, when the sand dries out rapidly. The shaft does not appear to receive any lining.

Short enlargements of the shaft occur here and there, but it would seem that these are more or less accidental, and concomitant on excavating in such friable material. The usual number of cells appears to be about eight, each of which measures 8 mm. at the long axis and 5 mm. at the short; a few larger ones measured 13 mm. and 7 mm. respectively.

The wall of the cell is covered with an extremely thin colloidal skin, which is licked on by the glossa, and when in the earth is of a dark umber-brown colour, but when exposed to the air it dries quickly, and becomes pale grey. Although the covering is so tenuous, yet it is thoroughly waterproof. The author has not yet found a solvent for this colloidal membrane.

When quite dry, the skin is exceedingly brittle, and tiny portions of it may be removed from the earthen wall, but it is impossible to secure a



Figs. 2. 2a.—Shafts of *P. fulviventris*.

2. Graphic diagram of tumuli on the surface; one showing two entrances under a cowl of sand.

2a. Graphic section of shafts and cells. (1) Partly formed cake of pollen. (2) Completed cake. (3) Cake with bee's egg. (4) Fully-grown larvae. (5) Pupa. (6) Adult female in shaft.

large piece. The lining is much more evident than the extremely thin skin of *Halictus,* where it is difficult to perceive any lining at all.

The author was not successful in finding a complete plug of mud or earth for closing the cell, as in *Halictus,* consequently, he would say that after the colloidal lining is drawn over to close to the cell, the short gallery is just filled in with loose sand, although the main shaft is left open. The entrance of which is, of course, easily closed by rain or wind.

In making very careful excavations, it was observed that cocoons of mutillid parasites appeared to be firmly surrounded by solid sand, for not the slightest trace of any connecting gallery could be found. Although the sandy loam is easy to excavate, yet its soft friable character makes extremely difficult the task of following down any one particular shaft with perfect success.

On October 15, 1941, Owen Dawson, R.A.A.F., of Clyde, Victoria, was building a house at Dandenong, some 22 miles east of Melbourne. On a clear hot day he observed a darting flight of insects about six inches above small shafts in the ground. They were probably females, although this observer did not catch any for determination.

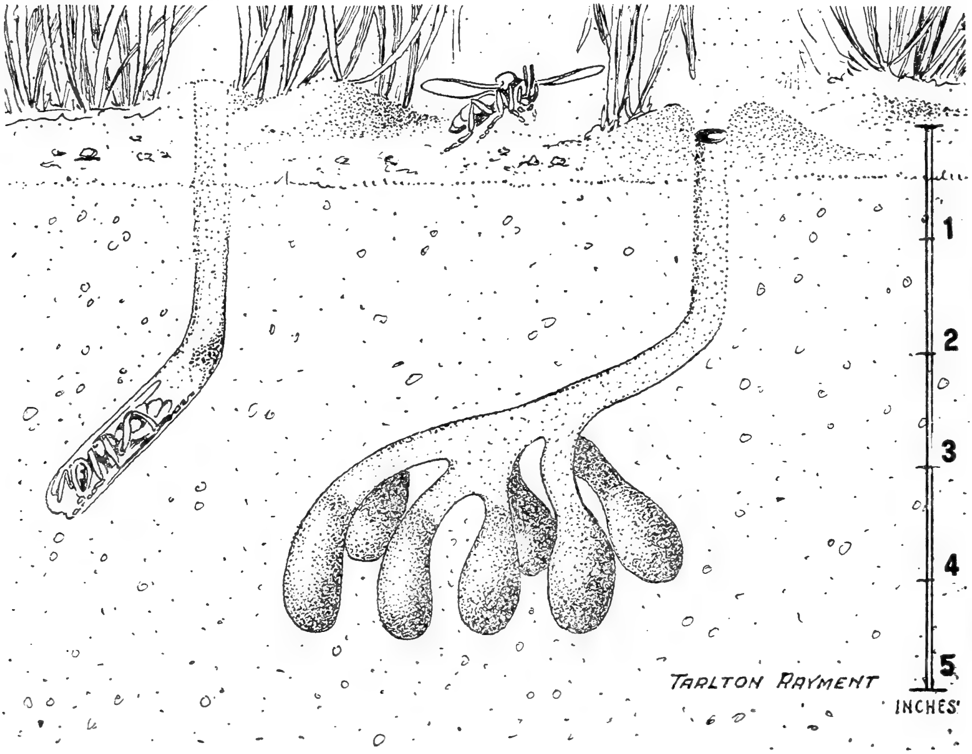


Fig. 3.—Graphic diagram of cluster of cells of *Parasphecodes subfultoni* Ckll. The arrangement approaches that of the bee, *Nomia australica,* and the wasp, *Cerceris.*

However, he made a closer examination of the site, which had a mere sprinkling of gravel over a rather loose black loam. There were no moundlets of freshly excavated soil about the shafts, so the bees were probably beginning on the new chambers to receive the eggs.

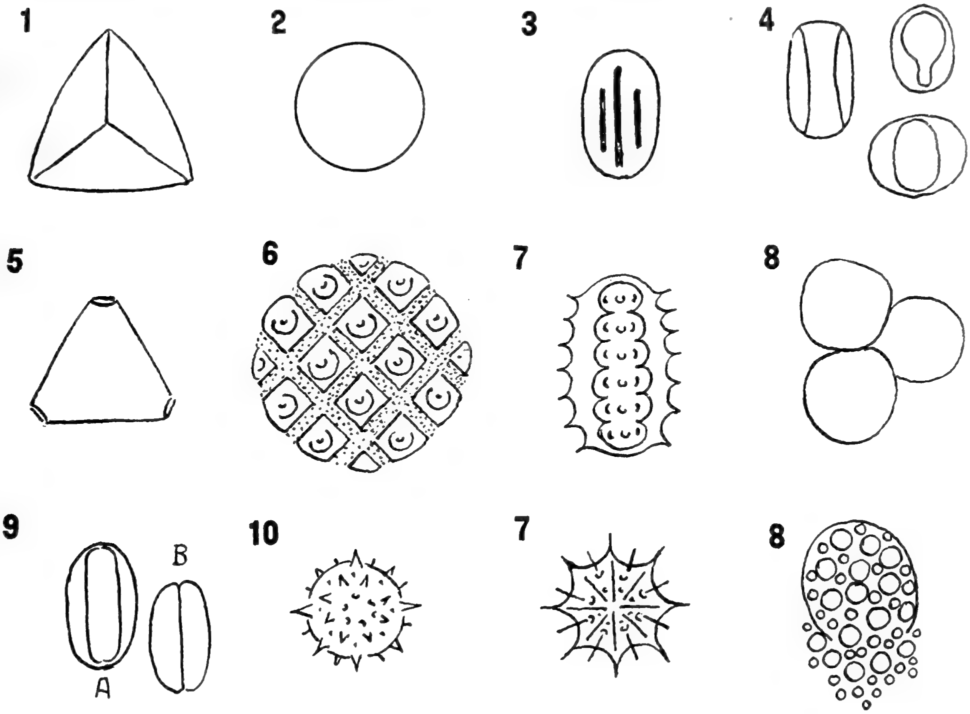


Fig. 4.—Granules from pollen-pudding of *P. fulviventris.*

1. Pollen-grain; probably from Tea-tree, *Leptospermum laevigatum.*
2. Large spherical grains not identified.
3. *Hibbertia sticta.*
4. Purple coral pea, *Hardenbergia monophylla.*
5. *Eucalyptus*; species uncertain.
6. Pollinium from Coast-wattle, *Acacia sophorae.*
7. Granule not identified and view of end.
8. Large fat-cells in fat-body of hibernating female, and a fat-cell breaking down; it is later absorbed.
9. (A) Not identified. (B) Parrot pea.
10. Spherical spiny grain, probably Flatweed; Compositae.

—Tarlton Rayment, del.

Dawson excavated a number of the shafts, and found the cells at a depth of only six inches, with short galleries opening off the main shaft in a more or less radial pattern. Each of the galleries terminated in an ovoid chamber, measuring 15 mm. at the long axis, and about 8 mm. at the short.

He described the new cell-lining as being of medium-grey colour, with

darker mottling; the old cells were just the colour of the earth, and he thought the cell wall would be less than 1 mm. in thickness. In a few of the new cells were traces of orange-yellow pollen, as though the bees had just commenced to store fresh provisions. Later, the author was able to verify these details.

A number of specimens was collected by this observer, and the author was able to determine them as *Parasphecodes subfultoni* Ckll., which was described from "Victoria" (F. E. Wilson, 1923). This species is considerably smaller than *P. fulviventris*, being about the size of *P. arciferus* Ckll.

Plants visited by *P. fulviventris* at Sandringham:—

Mexican Orange Flower .. .. *Choisya ternata* (intro.).
Flatweed .. .. *Hypochaeris radicata* (intro.), Compositae.
Capeweed .. .. *Cryptostemma calendulaceum* (intro.), Compositae.
Marluck Tree .. .. *Eucalyptus lehmanii,* Myrtaceae.
Yellow Gum or White Ironbark .. *Eucalyptus leucoxylon* var. *macrocarpa,* .. .. Myrtaceae.
Swamp Mahogany .. .. *Eucalyptus botryoides,* Myrtaceae.
Scarlet Gum .. .. *Eucalyptus ficifolia,* Myrtaceae.
Red Gum .. .. *Eucalyptus calophylla,* Myrtaceae.
Sugar Gum .. .. *Eucalyptus cladocalyx,* Myrtaceae.
Purple Coral Pea .. .. *Hardenbergia monophylla,* Leguminosae.
Guinea Flower .. .. *Hibbertia stricta,* Dilleniaceae.
Parrot Pea .. .. *Dillwynia ericifolia,* Leguminosae.
Cedar Wattle .. .. *Acacia terminalis,* Leguminosae.
Coast Wattle .. .. *Acacia sophorae,* Leguminosae.
Broom .. .. *Genista* sp., Leguminosae.
Boobialla .. .. *Myoporum insulare,* Myoporaceae.
Christmas Bush .. .. *Bursaria spinosa,* Pittosporaceae.
Tea Tree .. .. *Leptospermum laevigatum,* Myrtaceae.
Tea Tree .. .. *L. myrsinoides,* Myrtaceae.

Composition of February Puddings.

No.	Eucalypts.	Acacia.	Flatweed.	Heath.	Undetermined
1	80%	10%		1%	9%
2	94%	1%	1%		4%
3	94%	1%	½%		4½%
4	70%				30%
5	96%	½%			3½%
6	90%	5%			5%

The Egg.

Of all the bees' eggs studied by the author, only that of *Parasphecodes* has both ends inserted in the pollen-pudding; consequently, it is the most bowed of Australian bees' eggs, and resembles the handle of a minute basket. All of the new cells examined in this research contained eggs of this form, with the caudal end buried in the pudding.

The egg is crystal white, gleaming in the light, and measures approximately 3 mm. in length, with a diameter of 1 mm., when first laid—a large egg for such a small bee.

The chorion is extremely smooth, making it difficult to detect the exceedingly delicate hexagonal sculpturing, which is, of course, the imprint of the secreting cells lining the ovarian tubules, and only in critical side-

lighting under the microscope can it be detected with certainty. There is, however, a delicate striated pattern, and this is much more easily detected. It must be concluded that this striated sculpture is due to the condition of the larva within.

The egg increases in size before hatching; the caudal end is partially withdrawn from the batter, and the cephalic end rises a trifle from the pudding. Opaque white patches appear, and these, together with indications of segmentation, may be observed through the chorion. The head of the young larva does not reach to the end of the egg, leaving a space which remains pellucid as the body becomes more and more opaque. The caudal end of the egg is tipped with a hyaline agglutinative secreted by a gland at the apex of the female abdomen.

The exact time required for hatching could not be ascertained, but it appears to be about four days, when the egg splits open at the cephalic pole, and the chorion falls away, leaving the young larva occupying the original position of the egg. When first hatched, the larva exhibits a peculiarity in the spiracles, which are raised above the body, and with the tracheae resemble microscopic corrugated shafts or funnels.

The young larva lies quiescent on the pudding for a few hours, apparently sustained by the yolk of the egg, which it had ingested prior to hatching. The head is lifted up about 1 mm. from the surface of the pudding, and it rests in this position for several hours.

Larval Food.

The pollen-granules are carried on scopae of branched or forked hairs of several kinds; those on the coxae being five-branched; on the trochanters and femora they are long, slender, forked and curled; on the outer surface of the tibiae the hairs have one, two or three forks, but on the basitarsi they have five forks, and are shorter and stiffer. The bulk of the pollen, therefore, is carried on the legs, although there is a moderate amount transported on the scopa of the gaster, and, fortuitously, a few on the thoracic hairs.

The russet-coloured pollen-pudding is not truly spherical, dry and firm, like that of *Halictus,* but is much softer, since it contains more honey, and the base is widest, as though a soft sphere had gradually settled down on to a flat base. It is about 6-7 mm. in diameter.

Pollen gathered from the anthers is invariably lighter in colour than pollen taken from the body of the bee. It was observed that the harvester frequently moistens the anterior pair of legs with the glossa, and probably the pollen-rakes on the tarsi; this moistening no doubt assists dry pollen to cohere better.

Once again the author would stress the fact that, even in such primitive genera, the store is not a simple mixture of honey and pollen, but contains also a modicum of some biological secretion. This is probably secreted by the head glands, and added from the mouth during harvesting, and perhaps during the flight home, and later when the pudding is being formed. This substance, although small in quantity, is a vital factor in the development of the normal insect—a hormone not yet thoroughly investigated.

At present, research work on the food of bees is largely neglected, and until much more is done the phenomena of the various "castes," in the social bees, present a problem no less interesting than the genetical mechanism in such parthenogenetic genera as *Halictus* and *Nomia.*

The larva, when eating, does not sweep regularly across the pudding, taking off a slice as it goes, which is the manner of *Halictus emeraldensis*. The larval jaws are exceedingly sharp and needle-like, but the larval ingestion is like a toothless human "mouthing," a spoonful of porridge, and the baby eats whatever portion is within reach.

About 8-9 days are required for the complete ingestion of the pudding, when the larva shows a dark lead-coloured streak along the dorsal surface, and a similar dark patch marks the accumulation of the residues in the sac before the complete junction of the mesenteron and the proctodeum is effected.

About five days later, when the alimentary canal is complete, thirty or so dark-brown stercoral pellets are expelled in a more or less moniliform chain. Thereafter, the larvae are crystal white, of virgin purity. The pellets were examined under the microscope, and a number exhibited minute bosses of clear, smooth amber.

The excreta were carefully washed away, and several slender horn-like capsules were recovered. On breaking these on a micro-slide, a very large number of oil-globules escaped. It would appear that the larvae of *Parasphecodes* cannot use all the natural oils in the pollen-granules, and the great excess is voided in these curious capsules. The author has not observed these formations in the stercoral pellets of any other genus, although there is often a percentage of oily matter present. The author did not determine whether they were peculiar to one sex only or not.

Snodgrass, 1925, says "the fats are apparently but little used by the bees. Though pollen is rich in oil, much fatty material accumulates with other refuse in the intestine, as shown by Petersen." The blood of the hibernating adult bees contains many oily globules which appear to be liberated from the fat-cells, and Straus, 1911, says the larva of the honey-bee stores more glycogen than any other free-living animal.

The fat-cells of the "hibernating" females contain large oil-globules, and the cells themselves disintegrate, and so liberate the globules into the blood. Whether or not this apparently natural dissolution of the fat-cells is necessary for nourishing the body during the semi-hibernation is not known, but there is no doubt that the fat-cells disintegrate as a natural process as maintained by Snodgrass for the honey-bee.

The larva exhibits a number of nodes, and in the pupal stage these quickly develop into a series of long "studs" or tubercles, the most prominent being on the scutellum and postscutellum, but the hind margins of the tergites are also tuberculate, each having up to ten. These nodes are characteristic of Halictine pupae, and it must be concluded that *Parasphecodes* is exceedingly close to *Halictus,* although the nodes are not so prominent. The ventral node, a specific character, soon appears. Antennae, legs, and tergites 1, 2 and 3 are still drab when the head and thorax are quite black, as are tergites 4, 5 and 6.

The postscutellar nodes persist in the adults in the genus *Nodocolletes* Raym., 1931, as large concave bifid processes, but they disappear altogether in all other Australian bees studied by the author. The spines of the coxae are, with few exceptions, retained by adults in the leaf-cutters, Megachilinae; but disappear entirely in *Apis,* the hive-bee. The anterior tibial spine is retained by all bees, and ultimately becomes the strigil, or antenna cleaner. The spur of the median tibia develops into a calcar in all bees.

Larvae which ejected the stercoral debris on February 18 shed a larval pellicle on the 22nd, probably the third ecdysis, but, at that date, there were not any signs of colour in the body. A creamy opaque tint appeared on March 5, and the ocelli and the compound eyes turned the palest purple. Five days later, fine blackish margins appeared on the abdominal segments, the head exhibited a pale slaty colour, and then the thorax darkened. On March 18 another pellicle was shed, and the pupa changed slowly to dark lead-colour, except the red parts of the abdomen, which were still pale-cream in tint, the red parts coming last of all. The wings remained milky. The blackish suffusion strengthened quickly, and, two days later, March 20, the final pellicle was shed, and the insects were ready for flight. All these proved to be males, and the period of development was 56 days.

A generation of males and females, maturing in the field, about March 20-22, appeared on the trees at about the same date as the laboratory specimens emerged, so that development in the laboratory must have been normal, since it corresponded with what took place in the field.

Behaviour of the Individual.

The pupa twists and wriggles until the final skin is cast off, and it rests in the cell for a day or two, during which time the wings lose their milky tint and become suffused with blackish.

The insect then begins to tunnel out along the short gallery, which is filled with loose sand. Stubborn grains are wrenched out with the mandibles, and the more friable material is thrust behind with the legs. The exit presents no great difficulty owing to the complete absence of stones. The main shaft is ascended just as easily.

Emerging to the light at the surface, the bee rests in the sun for a minute or two before taking wing. Almost immediately a rather chalky-looking liquid is voided, and which, on testing with a litmus strip, gives a strong acid reaction. This is very marked in the genus *Hylaeoides* (Rayment, 1940), which voids a very large quantity.

The males take off for the blossoms to refresh themselves, and make little attempt at orientation, nor is there much need to do so, since the site of the colony is so extensive, and the soil varies not at all over the whole area; few ever return.

Among the flowers the sexes meet, and copulation frequently takes place amid the actual stamens of the gum-blossoms. Other species of *Parasphecodes* were observed copulating on the much smaller flowers of Boobialla (*Myoporum insulare*).

Refreshed with the nectar, the female returns to the colony site, and immediately seeks a satisfactory place to commence digging. After a few grains have been removed with the mandibles, the mother frequently abandons her first choice, and recommences a few inches away, although there are no differences apparent to the observer in the two places.

The excavating is effected with the mandibles and the legs, and the damp pellet—approximately a match-head in size—is hauled to the surface, and pushed out, without exposing the worker. The tumulus grows from beneath as the spoil is added to the base. During cold weather, the females remain in the cells, perhaps for three or four days.

The female rarely sits at the portal of the shaft, as is the habit of

many Halictine bees, and the only time she appears to do so is when something moves in the vicinity as she is about to depart. She will then close the aperture with her head, but any untoward movement will send her down the shaft instantly.

The males have not been observed in the vicinity of the shafts after their initial departure, but, at evening, the males of the colony assemble and form a rather compact, but unsymmetrical cluster on a twig of a shrub for mutual warmth.

These aggregations are no doubt an elemental stage of the clustering instinct of the honey-bee, *Apis,* and similar congregations of males have been observed by the author in several other genera, for the instinct is very strong in the Apidae.

In another Halictine genus, *Nomia,* the males of three species were observed to cluster together at evening. One such aggregation contained the large *N. ruficauda, N. gracillus* and the smaller *N. flavoviridis;* all these are more or less metallic in colour. Large "swarms" of *N. australica* have been observed, and Doctor Lieftinck, Buitzenzorg, Java, N.E.I., sent a photograph to the author showing a cluster of Nomiine males. The clustering instinct is very strongly developed in *Paracolletes,* and large "swarms" of *P. plumosus* Sm., and *Heterocolletes capillatus* Raym., 1935, have been observed by the author.

The clustering of the males is a Halictine habit, and this formation may be continued throughout the day in adverse weather, but generally it is broken very early in the morning, when the bees depart for the flowers.

Owen Dawson reported to the author that when stationed at Rocklands, Victoria, with the R.A.A.F., he passed under a low branch of a gum-tree, and immediately a swarm of small red bees took wing. However, they soon reformed the cluster, after he had passed. He repeated this several times, and collected a dozen or more of the bees, all of which were males that agreed very well with the description of *P. sextus* Ckll.

The female experiences little difficulty in returning to her own shaft, although there are so many close at hand. The natural conditions are such that plants of some kind grow close to the aperture, and no doubt these serve as landmarks to guide the homing bee. Even the total clearing of the site did not create any great difficulty, and the bees alighted within two or three inches of the aperture, which they soon located, probably by scent, as they often come up against the wind.

The nectar, of course, is carried in the honey-sac, and is "licked" up from the nectary of the flowers by the pointed glossa. Just how this is effected is not quite clear, but the hairy tip of the "tongue" lies flat on the surface of the ovary of the flower and is moved backwards and forwards very rapidly, without being turned over. The large paraglossae and the maxillae appear to assist in the ingestion of the nectar, but it is extremely difficult to determine the actual functioning of the complicated mouth-parts.

The author has observed both *Parasphecodes* and *Halictus* ripening the newly-gathered nectar by sitting in the warm sun and extending the mouth-parts. The bee exudes a large drop of nectar and, since the submentum is "hinged" at the base, a rapid extension and contraction of the liquid takes place, and it may be seen to thicken during the process. Park,

1932, claims that manipulation by the mouth-parts plays an important part in the ripening of nectar by the honey-bee.

Although many Australian wild-bees are endemic, confining themselves to one botanical species, this is not true of *Parasphecodes,* for it visits a wide range of plants, as the botanical list indicates. Like the hive-and most wild-bees, the insect confines itself to one species whilst harvesting, for the author finds no admixture of pollen-granules on the body—except, of course, an accidental one, probably adhering from a previous journey. No matter whether the pollen be bright-orange (Flatweed), or cream-colour (Eucalypts), the puddings in the cells, during February, are invariably olive-green in colour. There is not any after-feeding, and the original pollen-pudding is the total amount of food provided for each larva.

Order of the Generations.

The research demonstrated that three generations are present in this species during the season: A spring one of males and females; the second, a summer brood of males and females; the third one, of males and females, appears late in autumn. The individuals of the three generations are necessarily early and late in emerging, as the case may be, and it is unwise to fix specific dates for their appearance.

The bees emerge to flight in spring from, say, September 15 to October 1, the second half of which is spent in working at digging and provisioning cells, and depositing eggs; the flying bees then disappear.

During November and December, the larvae are developing in the cells in the earth. In the early days of January, a new generation of males and females is a-wing, and the latter portion of January is spent in labour. During February and early March, another generation is developing in the earth. These males and females emerge, and are a-wing during the latter half of March, and there are many matings during the early part of April. The males then disappear—succumbing to the cold during early May. The larvae develop in the earthen cells to hibernate over the winter, and emerge during the ensuing spring. The phenomenon of parthenogenesis is not present in this species.

Semi-Hibernation.

Numbers of "nests" were excavated by the author during June and July. The bees appeared to be perfectly developed in every way, and when uncovered to the light of day immediately began to dig into the loose soil about them. At first they are lethargic, but their movements soon quicken. At no time are they so active as summer females surprised in their cells.

It is quite clear that these wintered females are the progeny of the mothers of the previous April, and which were in the company of many males on the flowers of *Eucalyptus leucoxylon* var. *macrocarpa,* and *E. calophylla* var. *rosea.* Many copulations of the sexes on the blossoms were recorded on March 21, 1942, and the mated mothers were digging energetically down below, for moundlets of new yellow spoil were observed up to the 1st of April.

The breeding experiments demonstrated that up to 56 days are required for the development of the February-March females; consequently, eggs deposited early in April would produce the last brood for the season, and the latest would mature before July. They then pass through the winter in their cells in a state of semi-hibernation.

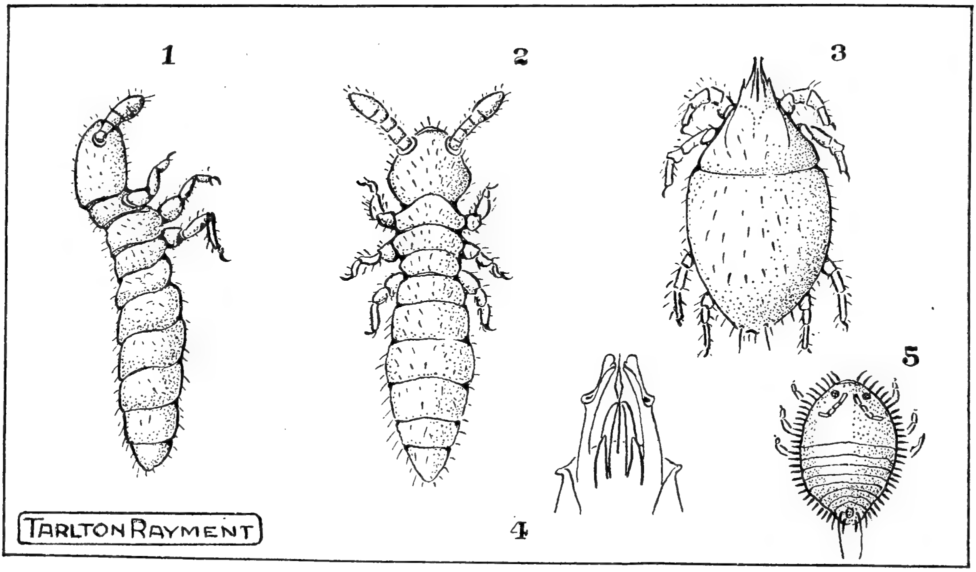


Fig. 5.—Inquilines and parasites of *P. fulviventris* (Fr.).

1. Lateral view of Collembolan, *Onychiurus fimetarius* L.
2. Dorsal view.
3. Acarid mite, *Caloglyphus berlesii* (Michael).
4. Stylets of the mite.
5. Remarkable insect taken from the gena of *Parasphecodes subfultoni* Ckll. This is probably a Coleopteran, but it was not studied.

Microscopical examination of the abdominal organs disclosed that the honey-sac had never contained any food, nor had the stomach (ventriculus), which was quite empty. A remarkable feature was found in the Malpighian tubules; these are lined with a bright-yellowish substance, discharged almost immediately after the insect first takes wing. Thereafter, the tubules are practically colourless. The ejected substance represents the body-waste accumulated during pupal development.

Parasites and Inquilines.

It was observed in the laboratory that numbers of the bees' cells were visited by minute white insects, resembling Collembola, but minus the abdominal spring of that genus. These insects averaged about 1,000 microns in length and were submitted to H. Womersley, of the South Australian Museum, who determined them as *Onychiurus fimetarius* L., which has a world-wide distribution in the humus of soil.

The author has no doubt whatever that in the earthen chambers the moisture would soon bring about an insanitary condition only for the activities of these insects and certain Acarid mites. It was observed in the field that none of the cells contained any stercoral or other refuse; indeed, even the cast skins of the several ecdyses soon disappear.

There is a symbiotic relationship that is distinctly beneficial, if not

essential, to the welfare of the larval bees. There is not the horde of acarid mites present in *Halictus emeraldensis* (Raym., 1937), but the same work is accomplished by these insects and mites, for the cells are always immaculate and entirely free from moulds.

The parasites' visits to the cells are fairly regular, but, as the insects exhibit a strong aversion to light, it was possible to observe them only by surprise; a very unsatisfactory method at any time. However, the author did not succeed entirely in defeating the tropism; consequently, the observations are not as complete as he would like them to be.

No Acarid mite was observed in the numerous cells examined, but many were discovered in the field at Rocklands (December, 1942), on the larval bees of *P. sextus,* but one was taken from the earth nearby. This mite measured 750 microns in length, and was determined by Womersley as *Caloglyphus berlesei* (Michael), which is often found in termitaria and decaying organic materials.

A very remarkable minute ovoid insect, some 380 microns in length, was removed from the gena of one specimen of *P. subfultoni,* collected by Owen Dawson, at Dandenong, Victoria, but the author has no other information on the specimen, and for the time being defers a discussion on its taxonomic position.

A Mutillid Wasp.

During the excavation of the site of the nests, large numbers of small drab cocoons, some 3 mm. in length, were collected at various levels. These appeared to be encased in solid earth, since no signs of cells could be detected.

They were removed to the laboratory, and critical examination revealed them to be the thin skin-like cocoons of a small Mutillid wasp. The large numbers of these indicate that *Parasphecodes* is heavily attacked by Mutillids.

The behaviour of these parasites has been closely observed by the author, and the procedure does not vary, whether it be on *Halictus* or *Parasphecodes,* the Mutillid searches the surface of the site, and, discovering a shaft, does its utmost to scent the presence of the bee.

Should the rightful occupant be absent, the Mutillid runs down the shaft, and, quickly depositing her egg on the body of the larval bee, hastily returns to the surface. Should the shaft contain a bee, the parasite immediately beats a hasty retreat to try her luck elsewhere. Sometimes the usurper is chased out by the irate mother. The ovipositor of the Mutillidae is very short, but the parasite is close to its host's body.

A number of larger reddish cocoons were obtained, but these were all empty, making it impossible to determine which insect made them, but as they were numerous, it appears that another parasite is present at some period, and the author would suggest that it is an Ichneumonid wasp, perhaps a Cryptine, in the genus *Labia,* as an undetermined species was observed at no great distance from the site. The biology of the earth-digging bees in the subfamily Halictinae is an extremely difficult study; a fact often stressed by the late Professor W. M. Wheeler.

An Internal Parasite.
(A Nematode Worm.)

Whilst dissecting some of the hibernating females in isotonic salt solu-

tion, nematode worms were observed swimming among the organs with an eel-like motion. The parasites were very small, measuring 650 microns in length, with a diameter at the thickest part of 25 microns. Although the host had been killed with ether, the parasites continued to be exceedingly active in the isotonic solution until killed instantly by a drop of acetic acid.

Although the locomotion is eel-like, the worms frequently whip themselves into a circle, or even a figure eight conformation, when they remain still; after a second or two, the quick undulating motion is resumed.

It was observed that nematodes were not enclosed in any part of the alimentary canal, but were swimming freely among the organs. Indeed, so far as could be ascertained, the canal had not been punctured, but it was noted that the whole interior of the abdomen was markedly deficient in blood. This peculiar dryness was detected in other hosts of the parasite.

Large numbers of larvae and also active summer female bees were dissected, but nematodes were not observed in any. It would seem, then, that the parasites somehow gain admittance to the abdomen during the long period of semi-hibernation over the winter months, but just how they enter the body of the bee was not determined.

The organs did not appear to have suffered any structural injury, but the loss of so much blood and fat must undoubtedly affect the vitality of the bee, and perhaps preclude its emergence in the spring. A percentage of such infected females may perish in their natal cells, but no dead bodies were discovered in any of the nests excavated by the author. Externally, there is nothing whatever about the body of the bee to indicate the presence of the parasites within the abdomen.

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EXPLANATIONS OF PLATES AND FIGURES.

Plate vii.

Anatomy of *P. fulviventris* (Fr.).

1. Adult female *P. fulviventris* (Fr.).

2. Rugose sculpture of metathorax.
3. Bidentate mandible.
4. Nodulose second sternite of female.
5, 6, 7. Fourth, fifth and sixth sternites.
8. Fifth tergite of female showing the apical rima of the Halictine family.
9. Sixth tergite showing plate under rima—all abdominal plates as pressed flat by the cover-glass.
10. Labrum of female has the angular appendage of the Halictine family.
11. Fifth tarsal segment with anguiculi and empodium.
12. Sculpture of clypeus showing the median depression.
13. Hairs on wing-surface.
14. Slender curled hairs of femora and trochanters.
15. a.b.c. simple, bi-forked, and tri-forked hairs from outer side of tibiae. d. five-forked hair on outer side of basitarsi. e. compound hairs of coxae.
16. Rugoso-punctate sculpture of frons.
17. Eleven hamuli of hindwing.
18. The small brush, distally on basitarsus, is another Halictine character.

Plate viii.

Larval development of *P. fulviventris* (Fr.).

1. Caudal end of the bowed egg is inserted in the soft pudding.
2. The hexagonal pattern on the egg is almost invisible; the striated pattern is more evident.
3. On larvae three days out of the egg—
4. The tracheae appear to be above the spiracles.
5. The larva after the pellets have been ejected.
6. Stercoral pellets showing tips of the oil capsules (a).
7. Nodes on scutellum and postscutellum of pupa before pigmentation.
8. Hind margins of tergites are tuberculate, as in *Halictus*.
9. Pupa before pigmentation.
10. The developing mouth-parts.
11. Invagination of apical segments of male abdomen during pigmentation.

Plate ix.

Anatomy of *P. fulviventris* (Fr.).

1, 2, 3. Motions of Nematode worm parasite.
4. Lateral view of open proventricular valve. Arrows indicate direction of flow of honey through proventriculus to true stomach (ventriculus).
5. Oblique view of valve when closed.
6. Apex of open valve.
7. Ciliated margin of "leaf" of valve.
8. Submentum and glossa, paraglossae, and labial palpi of female; viewed by transmitted light.
9. Maxilla, galea and maxillary palpus of male.
10, 11, 12, 13. Dorsal, ventral, lateral and oblique views of genitalia of male.
14. Strigil of female.
15. Calcar of female.

Plate x.

Portion of the railway bank occupied by the huge colony of *Parasphecodes fulviventris* (Fr.). Photograph by the author.

FREDERICK STRANGE.

A Biography by MAJOR H. M. WHITTELL, O.B.E.,
Bridgetown, Western Australia.

(Plate x.)

John Gould, John Gilbert, John Macgillivray, and Frederick Strange were naturalists to whom we owe a large amount of our knowledge of the animal and bird life of the eastern districts of Australia during the early days of the colonisation of New South Wales and Queensland. The account which follows is intended as a contribution towards our knowledge of the work of Strange, who was undoubtedly one of Australia's great pioneer naturalists.

Frederick Strange died a tragic death in 1854 whilst still a young man, leaving a wife and young family in Sydney, many miles from his home country. In 1854 it was still a long, long journey to Australia, where scientific institutions were few and far between and, as most of his collections in natural history had gone to England, his attainments as a naturalist were better known there than in the country of his adoption.

To those reasons may be due the fact that no account worthy of the extent and results of his pioneer work in natural history in Australia and New Zealand has so far been published.

Mammalogy, ornithology, entomology, conchology, and botany are all in his debt for the work he did in first bringing to knowledge many items in those sections of natural history. Possibly, too, it is due to the wideness of his activities that no specialist in any one of those sections has honoured his memory by writing an adequate account of his labours.

True, some attempt to do justice to Strange's efforts occurred when a pamphlet entitled "Literary Notices of the late Frederick Strange, Naturalist," was published. The author (1) and date of publication are unknown, but from information contained in it the pamphlet must have been printed after November, 1865, as there is an article by Gerhard Krefft on the Yellow-footed Wallaby, *Petrogale xanthopus,* which mentions specimens collected in the Flinders Range by George Masters, who collected there in November, 1865.

In this pamphlet, of which there appears to be only one known copy, is reprinted, from the *Sydney Morning Herald,* an editorial article of 1852 intimating that the naturalist was about to visit England, together with an account of him, which appeared in the British press on his arrival in London. "Notes on the Brush Birds of Australia," by Strange, are reprinted from the *Moreton Bay Courier,* and an account he wrote in the *Sydney*

(1) Frederick Strange married Rosa Prince. In 1856 (see *post*) her address was c/o Mr. Charles Prince, Herald Office, Hunter Street, Sydney. In the Sydney *Directory* of 1855, Charles Prince is recorded as residing at Princes Street, occupation, compositor. We may, therefore, assume that the pamphlet was set up as a private effort by Charles Prince, who was probably father or brother to Mrs. Strange.

Morning Herald of a trip inland he made in New Zealand. Details of the tragic ending of the naturalist are reprinted from various Australian newspapers and, as already mentioned, there is an account by Krefft of the Yellow-footed Wallaby.

Except for this pamphlet, the only biographical notes published have been those in the short account by J. H. Maiden in his article, "Records of Australian Botanists," which appeared in the *Proceedings of the Royal Society of New South Wales* in 1908.

Maiden's information appears to have been limited to that contained in the pamphlet, and any casual references to Strange that have since appeared have been confined to the contents of Maiden's article (2).

Maiden wrote of Strange as a botanical collector. Iredale and Hedley have made mention of him as a conchologist.

Strange was the first to make several Australian mammals known to science, and still more Australian and New Zealand birds, yet it is a curious fact that, although many items in conchology and botany have been scientifically named after him, his memory has never been honoured in the name of a mammal or of a bird.

Even that famous keeper of the bird collection in the British Museum, Robert Bowdler Sharpe, who joined that institution in 1872 and was acquainted with John Gould, was unable, when writing the history of the collection of birds, to record information about Frederick Strange. Many of the bird skins collected by Strange reached the British Museum in the Gould collection, but all that Bowdler Sharpe could place on record about the collector was: "Collected in New Zealand and Australia, and made beautiful skins. I have not been able to find out any records of his career, but I can remember that Mr. Gould always spoke of him with high appreciation as a collector."

For the purpose of this biography much more material than was available to Maiden has been used, since Frederick Strange's grandson, Mr. C. R. Strange, of Sydney, has submitted some of his grandfather's correspondence and has also supplied a note-book, entitled, "Catalogue of Mammalia and Birds of Australia," belonging to Frederick Strange, in which the naturalist entered field-notes on birds he collected in the neighbourhood of Moreton Bay and elsewhere. In the account which follows this note-book will be referred to as the "Catalogue."(3).

Extensive research in contemporary manuscripts and printed literature has furnished much additional information.

Birth-Place and Date of Birth.

When Frederick Strange arrived in London from Sydney in 1852, with a consignment of natural history specimens, the newspaper *London Morning Advertiser* gave an account regarding him in its issue of June 24 of that year. In that article Strange was described as a native of Aylsham in

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(2) Maiden published a photograph reproduced on plate x.

(3) From internal evidence it is apparent that this *Catalogue* was compiled before March 1, 1848.

Norfolk. Aylsham is about 11 miles north of Norwich (4), and about nine miles from the coast. When in New Zealand, in 1849, Strange named a mountain, Mount Stanley, after the Bishop of Norwich, Dr. Edward Stanley (1779-1849, father of the explorer, Capt. Owen Stanley, R.N.); and when he arrived in England in 1852, Strange proceeded to Norfolk, as is witnessed by an agreement drawn up in Norwich on September 17, 1852 (see *post*). The *Norwich Mercury* of June 26, 1852, printed the notice appearing in the *London Morning Advertiser* of two days previously, and in the documents in possession of Mr. C. R. Strange are letters to Strange from J. H. Gurney, the Norwich ornithologist, and from Trivet Allcock, also of Norwich.

It should also be noted that Strange called his house in Sydney "Norfolk Cottage."

The writer has gone to some pains in an endeavour to ascertain the date of birth of Strange. The parish registers of Aylsham, which date from 1653, have been searched, but there is no Strange entry between the years 1810-1818. A search among the large accumulated records and indexes of the Society of Genealogists of London has been equally unavailing in a search covering the county of Norfolk generally. Strange is a very ancient Norfolk name—appearing as Le Strange, etc.—but it seems to be very rare indeed in Norfolk records from the 18th and 19th centuries onwards. The secretary to the Society has kindly gone to considerable trouble in an effort to trace the year of Strange's birth, but without success. Maiden, in his *Records of Australian Botanists,* gave the date as "1826," but this, as will later appear obvious, is certainly incorrect.

Emigration to South Australia.

The notice in the *London Morning Advertiser* states that "previous to tne final adoption of his home in the new world," Strange "embarked in the third vessel which left the shores of England, in order to the formation of a new settlement in South Australia, where he remained 12 months prosecuting his labours in natural history, botany, and in acquiring information relating to the resources of the colony. (5) The *Cygnet* was the third vessel to leave England for South Australia, and it was a Colonisation Commissioner's ship, containing portion of the survey staff. Kingston, the Deputy Surveyor-General, was on this ship which left England on March 20, 1836, and arrived in South Australia on September 11 with 84 passengers.

H. A. D. Opie, in his *South Australian Records prior to* 1841, gives a list of the passengers by the *Cygnet,* but there is no record of Strange, nor does the name occur in any of the available lists of passengers on ships coming to Adelaide at this period. In view of the fact that Strange was engaged in fishing enterprise early in his South Australian career, if he did travel on the *Cygnet,* it is possible that he served as a member of the crew. He certainly had sea-faring knowledge, as later, when he went farther east to New South Wales, he was mate of a vessel, the *Tamar.* The

(4) In June, 1920, Mr. Tom Iredale saw in the Norwich Museum, Norfolk, *Psephotus pulcherrimus* from Moreton Bay, presented by Thos. Strange.—Ed.

(5) This is incorrect. Strange was in South Australia for about four years.

statement that Strange came to South Australia in the third vessel to arrive in that colony—the *Cygnet*—should be noted in conjunction with the fact that later he accompanied Charles Sturt and other surveyors in some surveys. It is possible that Strange became acquainted with officers of the Survey Department during the voyage of the *Cygnet*.

While time may furnish more information as to the beginnings of Strange's Australian career, we have a very definite record of him on July 14, 1838. In the documents in possession of Mr. C. R. Strange there is one under the signature of J. Hindmarsh, Governor of South Australia, written at Adelaide on that date:—

> "I certify that I have known Frederick Strange for the last six months, during which period his sobriety, honesty, and good conduct have been uniformly good and steady."

Strange, therefore, must have come under the notice of Governor Hindmarsh as early as January, 1838, or about 15 months after his (Strange's) first arrival in the colony, if he did reach the colony in the *Cygnet*.

We get certain information about Strange's movements in South Australia from the operations of some large investors or speculators. Also from a land transaction, which was to involve the then Colonial Secretary, George Milner Stephen, in a somewhat notorious and unsavoury case, and to lead to the resignation of his office and withdrawal from the colony. This refers to the episode of the "Milner Estate," in the first transactions regarding which Strange was involved.

Captain Charles Sturt spent September 26 to 30, 1838, in examining the country at the mouth of the Gawler River on behalf of the South Australian company and was accompanied by Frederick Strange.

Miss Gwenneth Williams, in *South Australian Exploration to* 1856 (Public Library, Adelaide, 1919), states (page 37): "Early in the following year [1839] Mr. [T. Bowes] Strangways made another trip in this vicinity, when with Messrs. G. M. Stephen and [W.] Nation he left Adelaide in search of rich country. Crossing the Lower Para they reached the Gawler River just below its junction with the Upper Para; then as they followed the stream fertile alluvial plains were discovered covering in extent hundreds of acres. The party now came upon a salt water creek, which was named after Strange, their attendant, who had discovered it two years previously when engaged as a fisherman. So promising was the neighbouring district that Mr. Stephens obtained a Special Survey."

Writing in the *South Australian Gazette and Colonial Register* of March 2, 1839 (6), Stephens said: " . . . we came upon a salt water creek, flowing into the Gulf (St. Vincent's) and which His Excellency Colonel Gawler has permitted me to name "Strange's Creek" after my attendant who led us to it, and discovered it about two years ago in a boat when a fisherman. I should mention that at about three miles from the outlet of the Gawler, Strange recognised the spot as the place to which he had accompanied Capt. Sturt last year (1838), and which the latter had described to the South Australian company and strongly recommended for a special survey; but

(6) Van Diemen's Land (now Tasmania), New South Wales (of which Victoria was a part) and South Australia.

which the manager did not inspect, or it would not have been my good fortune to possess it.

"We were tired, and therefore did not proceed far up the salt water inlet, being satisfied that large boats could discharge cargo upon the alluvial flat itself, but at all events upon dry land, and trusting to Strange's description of its entrance and short course from the Gulf. That description is abundantly confirmed by the written report of Captain Sturt to the company. Strange informed us that the creek so abounds with fish that, to use his own graphic description, 'the boat actually laid upon their backs,' and his last haul in it before he became a landsman amounted to 99 dozen, which he sold to other fishermen at Port Adelaide for £13 odd. Upon my return to town I took a Special Survey (February 20, 1839) in this spot from the mouth of the inlet up the bank of the Gawler as far as the water extends." (7).

Here we have the information that Strange, early in his South Australian career, was engaged in fishing enterprise in St. Vincent's Gulf, and before or about March, 1837, had gone as far north as the mouth of the Gawler River. Next we learn that Strange had accompanied Sturt when the latter surveyed the land at the mouth of the river, between September 26 and 30, 1838, and that he again went to that locality with Strangways early in 1839.

A portion of a mutilated letter among the "Strange" papers would suggest that Strange did more than just accompany Stephen when the latter went to inspect the land with a view to applying for a Special Survey. It is possible that it was Strange who first brought the suggestion forward to Stephen that the latter should acquire the land. The mutilated letter unfortunately bears no date, and the signature has gone, but it was undoubtedly written by Stephen, as it is endorsed "Colonial Secretary," and was probably written shortly after February 20, 1839, the date on which the Special Survey was claimed. It will be noticed that the letter was addressed to Strange, care of John MacLaren, who was a Government surveyor, and that Stephen (8) says he would request a week's leave for Strange. This would indicate that Strange was, when the letter was written, in the employment of the Survey Department.

(Addressed) Frederick Strange, care of Jno. MacLaren, Esq.

(Franked) Colonial Secretary.

"You will see by the newspapers, Strange, that I have taken a Special Survey of the fine place we have just seen. The Creek the Governor has allowed me to call after you 'Strange's Creek.' Being anxious to reward your services during my late excursion in a manner which I believe will be gratifying to you, I have only to say that on the other side of this sheet I have sent you an I.O.U. for £50, which you can have at any time or in any sums from time to time as you please. I have also in readiness for you an excellent Second-hand Double-barrelled Gun .... instru-

(7) In his *Catalogue* Strange recorded that he shot the Masked Wood-Swallow, *Artamus personatus,* in "1839, and then I shot it on the Gawler River in South Australia."

(8) Stephen's diary, November, 1838, to February, 1839, is in the Mitchell Library, Sydney, but I am informed by Miss Leeson it contains no mention of Strange.

mentability. I now send an express Messenger for you to come up to Emu to-night, if possible, in order to accompany Mrs. Lindsay and Mrs. Stevenson in a boat to-morrow afternoon to the Creek; for which purpose I shall request for you a week's leave of absence. But I shall be glad to have you entirely as my property with Mrs. Lindsay until we go home together, two or three months' time; and I will in the meantime give you the same .... first few days of your arrival .... Mrs. Lindsay .... you will be .... to pilot them about. I hope to place you upon .... Farm there by and bye as soon as .... established a town. You can therefore either resign .... situation or ask for the leave of a .... you please; but of course you will ....

I am your friend,

(Signature gone)."

Regarding *Malurus melanotus,* Gould wrote in his *Handbook* (Vol. I, 322): "The belts of the Murray in South Australia were the only places in which I observed this species. . . . The period of my visit was in winter; specimens I collected were all out of colour, or, more properly speaking, divested of the rich blue and black plumage, in which state a single specimen was afterwards forwarded to me by one of the party that accompanied His Excellency Colonel Gawler and Captain Sturt, when those gentlemen visited the Murray in 1839." Strange accompanied Gawler on the occasion referred to by Gould, and in his *Catalogue,* Strange entered "Belts of M.(urray) F. Strange" in the column "S.A." against *Malurus melanotus.* It is possible that Strange was with Gould when the original specimen was taken, and that he had a commission to obtain for Gould further specimens at the first opportunity which was to come when he accompanied Sturt on the disastrous visit in the following November-December. It was, however, probably before that trip that Strange visited the country between the Coorong and Lake Albert. That he did visit that portion of South Australia is apparent from records of mammals collected by him. In August, 1839, one Malcolm applied for a Special Survey of a tract of country lying on the eastern shores of Lakes Alexandrina and Albert, and it is possible that Strange was engaged as one of the party carrying out the survey and collected then the animals he sent to Gould. (See *S.A. Nat.,* 23, 1946, 11-13.) On his return from this survey duty Strange proceeded on the expedition which is referred to as follows in the *London Morning Advertiser:*—

" . . . In the latter end of this year, 1839, he was engaged upon an expedition with Captain Sturt and Commander Pullen . . . to explore the country north of the north-west angle of the Murray, during which the entire party nearly perished, being compelled to bleed their horses to quench their thirst on account of the entire absence of water." The catastrophe, while bad enough, was not so bad as pictured by the London paper. This was the expedition undertaken by Governor Gawler, with Captain Sturt and Lieut. W. J. S. Pullen, when it was proposed to cross Lake Alexandrina from Currency Creek (near the present town of Coolwa), proceed up the Murray to the Great Bend (later known as the North-west Bend), where

the town of Morgan is now situated, and thence return overland to Adelaide. It was to result in the death of Bryan, one of the party. (9).

Governor Gawler records that he sent out several parties of those who had remained at the camp to search for Bryan, and Strange was one of these. In her diary (10), Julia Gawler, under date December 15, at North-west Bend, wrote: " . . . at 6, Arthur (11), Mr. Pullen and Bob (12) went down the river on horseback, and a boat went down with six sailors to look for him, but returned without him. Arthur, Strange, and Bob set off up the country at 6 o'clock in the evening. December 16: Arthur returned without Mr. B. at 8 o'clock . . . at 8 o'clock p.m. . . . Strange, Craig and Richardson set off by land."

Captain Sturt in his report, published in the *South Australian Register,* (13), said: " . . . Richardson, Strange and Craig walked along the main road. . . ."

On December 21 camp was broken and the party reached Adelaide on December 28.

Settlement in New South Wales.

When or why Strange left South Australia is not known, but his *Catalogue* contains a note that he collected a specimen of *Pedionomus torquatus* in New South Wales in 1840. In the *Introduction to the Birds of Australia,* 1848, Gould wrote: "Independently of the plains of South Australia, formerly given as the restricted habitat of this species, I have lately received a letter from Mr. Strange, of Sydney, in which he states a female had been procured in the neighbourhood of Botany Bay. I am also in possession of an egg of this bird. . . ." Gould is more explicit in his *Handbook,* 1865, regarding the egg, when he wrote: "Strange sent me a fully developed egg of this bird which he took from the ovarium of a female. . . ." (See Whittell, *Emu,* 45, 1946, 328-329.)

Mr. C. R. Strange has a copy of *The English Version of the Polyglott Bible,* on the frontispiece of which is endorsed "From Frederick Strange to Rosa Prince, 1840." When or where the marriage took place is not known, but the baptisms of their children are entered within the front cover. These domestic occurrences will be referred to again later in their chronological order, but at the moment it should be mentioned that the first entry records the baptism of a son, George William, on December 10, 1841. Among the "Strange" papers is a burial certificate of this child showing that he was born at Gosford, New South Wales, on November 23, 1841, and buried at Gosford on October 20, 1842.

In the burial register Strange is recorded as "mate of the *Tamar* steamer," so it would appear that he had left South Australia to take up a

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(9) The full text of Colonel Gawler's despatch to the Colonisation Commissioners for South Australia on this journey was given by V. M. Newland as a supplement to his Presidential Address before the South Australian Branch of the Royal Geographical Society of Australasia on October 29, 1937. See *Proceedings for the Session,* 1936-37.

(10) MSS. in Archives Department, Public Library, Adelaide.

(11) Arthur D. Gell, Private Secretary to Governor Gawler.

(12) An Encounter Bay native employed as an interpreter.

(13) January 4, 1840, page 4.

seafaring life. By May 27, 1843, he had, however, moved to Sydney, as a son, Thomas Frederick (later to be the well-known New South Wales oarsman and sculler), was baptised there on that date. Strange commenced business as a collector of natural history specimens; the *Sydney Morning Herald* for 1844 contains several notices of his activities in collecting. The issue of April 20 records that: "Mr. Strange, of Princes Street, who is not unknown as a successful collector of specimens of natural history, returned this week from a week's collecting excursion up the Hunter. One of the chief curiosities he has brought with him is an enormous diamond snake, 11 ft. one inch in length. Mr. Strange walked close to this snake within five minutes of his landing on Musquito Island. . . . On opening it, Mr. Strange found in its stomach a paddy melon, a species on wallaby, fully two feet long. . . . Both snake and paddy melon are about to undergo the process of stuffing for exportation to England. In four days (the remainder of the week was too wet to go out), Mr. Strange has collected more than three dozen of various species of wallaby, besides a number of paddy melons; also a beautiful variety of birds and insects."

The *Herald* of August 23 gives a list of passengers arrived by the *Maitland* steamer from Port Macquarie. The list includes the name of "Mr. Strange," while the issue of September 7 shows, in the list of cargo by the bargue *Haidee,* for London, one box of specimens, natural history, F. Strange.

Meeting with John Gilbert and John Macgillivray.

When John Gilbert, on his second visit to Australia, reached Sydney at the end of January, 1844, there occurred a very interesting gathering of naturalist-collectors. Strange was then in Sydney, John Macgillivray was with H.M.S. *Fly,* and Dr. George Bennett was still there.

Mr. A. H. Chisholm, in *Strange New World,* has given the movements of John Gilbert in New South Wales, in 1844, and has published what he described as the last known letter written by him. The letter, published by Chisholm, was addressed by Gilbert to Dr. Bennett, and was dated from Darling Downs on September 10, 1844. But among the correspondence furnished by Mr. C. R. Strange is a still later letter addressed by Gilbert to Frederick Strange from Darling Downs on September 16. The letter is as follows:—

Darling Downs,
Sept. 16, 1844.

Dear Sir,—

I have packed up a small collection for Mr. Gould, and you would oblige me very much by sending them off by the first, and post the enclosed letter by the same vessel, the reason of my sending so small a collection is that I have determined on joining Dr. Leichhardt's overland expedition; would you not like to go? I am sure you will agree with me that such an opportunity of collecting the treasures of the interior should not be lost sight of.

I only received your letter of the 17th July (14) a few days ago, and of

(14) This was doubtless the letter referred to by Gilbert in his letter from Darling Downs of September 10, 1844, to Dr. George Bennett. Gilbert wrote: "I received a letter from Mr. Strange a few days ago, in which he states there are no letters from Mr. Gould." See *Emu,* 38, 1938, 147.

course have not yet received my boxes you have been kind enough to send, and the letter you sent from Mr. Lefroy I cannot hear anything of, although repeated inquiries have been made for me at the Post Office. I am glad to hear so good an opinion of Macgillivray, as I told you at first I could not think he would act otherwise; if we succeed in getting across I shall most likely surprise him at Port Essington, should a ship be leaving for that port; drop him a line to say I am on the way. You can unpack the box and look at the specimens, and if not giving you too much trouble, perhaps you will get a tin top soldered on to make it more secure; the only thing new in the collection is the parrot I mentioned to you in a former letter, and the smaller Quadrupeds, which I think are nearly all new. I am sorry I have not been able to get you a few beetles, but the weather has been so cold and cheerless that scarcely any insects are to be found. If we succeed in reaching our destination I shall get on to Sydney as soon as possible, so that I think you may expect me in about 12 months.

Believe me, ever yours truly,

JOHN GILBERT.

P.S.—Best respects to Mrs. S.

P.S.—There is a small package of seeds enclosed in the box for Mrs. Bennett. Will you be good enough to deliver it J.G.

The letter was addressed to "Mr. F. Strange, two doors from the Wesleyan Chapel, Princes Street, Sydney," and bears stamp "General Post Office, Sydney, October 24, 1844."

Among Australiana recovered by A. H. Chisholm in England in 1936 there is a draft of a letter from Gould to Gilbert, dated August 24, 1844, in which Gould wrote: "I have written to Strange, Drummond (15) and Mr. Bennett, all of whom I hope will collect. You will, therefore, give Strange a full list of desiderata when you leave."

But Gilbert did not receive this letter, as he had left on his fatal journey with Leichhardt before it reached Sydney.

Strange himself must also have left Sydney for the north shortly after Gilbert's departure with Leichhardt, since the *Sydney Morning Herald* of November 30, 1844, gave a list of passengers who arrived the day before by the *William the Fourth* from the Clarence River, and the list includes "Mr. Strange."

A daughter, Rosa Ann, was baptised at Sydney on June 18, 1845.

Although among the letters belonging to his grandfather supplied by Mr. C. R. Strange there is none from John Gould; still there is in Gould's *Letter Book*, 1840-1846 (16), a draft of a letter to Dr. George Bennett, which goes to show that Strange was eager to take up collecting on a grand scale for Gould. The letter reads: "A report has just reached London that Leichardt (*sic*), Gilbert and party have arrived at Port Essington. I fear this is too good to be true, but I do not despair of their safety, and this it is that has prevented me from acceding to Strange's solicitations to appoint him Gilbert's successor, which, of course, I could not think of doing while there is a chance of so admirable and zealous an assistant being in existence."

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(15) Johnston Drummond, of Swan River Colony.

(16) In Mitchell Library, Sydney. See *Emu*, 38, 1938, 211. Footnote.

The letter is dated from London, June 1, 1846, and it was not until March 25, 1847, that Leichhardt returned to Sydney and it became known to the world that he had actually succeeded in reaching Port Essington, but with the loss of Gilbert.

From a letter from Leichhardt to Dr. Bennett (17) it would appear that, after Gilbert's death became known to Gould, some arrangement between Gould and Strange regarding collecting was reached.

To this period may, perhaps, be allotted an undated letter written by Leichhardt to R. Graham, Sydney. This letter, the existence of which appears to have hitherto been unknown, is among the documents lent to me by Mr. C. R. Strange. The letter is as follows:—

My dear Friend,—

Mr. Strange told me that "Charley" the black fellow who went with me wanted some clothing. He is staying at present at the Clarence, collecting birds for Mr. Strange, and takes, to all appearance, great care of himself. You know best what arrangements are made to meet their wants, and will be kind enough to tell Mr. Strange. May I remind you of Mr. Gilbert's tombstone?

Believe me ever to be my dear friend most sincerely.

Yours,

LUDWIG LEICHHARDT.

R. Graham, Esquire,
Sydney.

This Graham was possibly the man after whom Leichhardt had named Mount Graham. The letter tends to confirm Mr. Chisholm's assessment of Leichhardt's character—was the explorer trying to pass on to some one else the responsibility of doing something for Charley? The same may be suggested about the tombstone to Gilbert. Why the letter should nowadays be among relics of Frederick Strange is obscure.

Visit to New Zealand in H.M.S. Acheron.

H.M.S. Acheron, under the command of Captain Lort Stokes, was engaged on a survey of the coasts of New Zealand from 1847 to 1851, and Strange was in the vessel during a portion of the period, leaving Sydney in the vessel as a passenger on October 30, 1848. Before actually going to New Zealand, Strange appears to have had some contact with that country. At the meeting of the Zoological Society of London, held on April 13, 1847, John Gould (18) read a letter from Strange containing "Notes on some rare birds of New Zealand and Australia." In the letter Strange gave some notes on *Strigops habroptilus* and *Apteryx australis,* as well as on the Australian bird *Scythrops novaehollandiae.*

From the remarks of Strange regarding the two New Zealand birds, it would appear that he had obtained his information from sealers who had put in to Sydney. The information that a second, larger, species of Kiwi

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(17) In Mitchell Library MS., No. C.161. See also *Emu,* as above, p. 151.

(18) *Proceedings,* Part XV., 1847, 50-51; reprinted in an article on the Birds of New Zealand in the *New Zealand Journal* of May 18, 1850, 118-119.

occurred on South Island was correct, but it was not confirmed until 1871, when Potts described *Apteryx haasti* from two specimens received at the Canterbury Museum from Westland. Meanwhile, Strange, himself, had obtained a new species, *Apteryx oweni* Gould—probably from a sealer—and a note recording the fact has been entered by him in his *Catalogue*. An entry, covering a page, gives a description of the species, together with a note "Mem. sent to England by me in the ship *Hamlet* in the latter part of 1847.—F. Strange."

The bird was described by Gould before the Zoological Society of London on June 8 (19), "On a New Species of *Apteryx*." "The bird I am now about to describe has just arrived from New Zealand by way of Sydney, but unaccompanied by any information as to the locality in which it was procured, or any particulars of its habits and economy."

In the *Birds of Australia* Gould wrote that *Apteryx owenii* "formed part of a small collection of New Zealand birds, but from which of the islands they had been procured was uncertain; I have some reason to believe that they were from the South Island." In his *Handbook*, however, he acknowledged his debt to Strange when he wrote: "The specimen from which my description was taken was sent to me by Mr. F. Strange, of Sydney, in 1850."(20). From Strange's letter to the Rev. Richard Taylor, it is apparent that the specimen came from the South Island. (21).

No connected account of the survey of the coasts of New Zealand by the *Acheron* has been published, and the writer has encountered difficulty in tracing the itinerary of the voyage. The ship, apparently, went first from Sydney to Auckland, and from there to Akaroa in February, 1849, where the nautical survey of Banks Peninsula was begun.

Between March 4 and 10 Strange made a trip up the Waimakariri River, and on his return to Sydney he published an account of the trip in the *Supplement* to the *Sydney Morning Herald* of January 26, 1850. (22).

The article is entitled "Port Cooper. Narrative of a trip 64 miles to the west of Port Cooper."

Quitting the ship on 10 days' leave of absence on March 4, 1849, Strange, with a small party, the personnel of which he does not state, but which, from the fact that they interested themselves in trapping rats, were probably Maories, reached the station of the Deans Brothers. Strange records having collected a Grebe (*Podiceps*) here.

The next day he continued his march, during which he saw a hawk (*Circus*), quail (*Coturnix*), and a gull (*Larus*). On the 6th the party continued up the river bank, and Strange records seeing a species of *Helix*, "but they were dead from the recent fires," and a flock of Black Duck, *Anas superciliosa*. He shot a pair of Paradise Ducks, *Casarca variegata*, "the putangitangi of the natives." The next day he went on and camped

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(19) *Proceedings*, Part XV., 1847, 93-94.

(20) Appendix to Vol. 2, 573. Here is another example of Gould's well known carelessness regarding dates.

(21) See *post*. Strange uses the then current name of "Middle" Island for South Island.

(22) This account was reprinted in the *New Zealand Journal* of 1850, and it also appears in the pamphlet, "Literary Notices, Etc."

at night "about three miles from the foot of the Snowy Mountains." His men made rat-traps and caught many Norway rats (*Mus rattus*). "This species appears to have over-run all parts of New Zealand, and as it destroys the *kiore*, or native rat, that species will soon be extinct. I learned from a native at Port Cooper that a few years ago the natives used to have their regular *kiore* hunting grounds, where they used to kill them by thousands. The only one I obtained during my stay at New Zealand was given me by the Rev. Mr. Butts, at Nelson." "In crossing over the plains to-day, in a place where there was an extensive dip of the country for many miles, I saw numbers of the bones of the *dinornis*, but mostly broken." He records getting "two new species of helix, and some fine insects" at this camp, seeing for the first time the Orange-wattled Crow, *Callaeas cinerea*, and finding the Parson Bird (Tui) *Prosthemadera novae-seelandiae* plentiful. At night he heard the plaintive call of the Woodhen, *"Ocydromus australis,"* or "weka" of the natives. This Woodhen was probably the form *Gallirallus hectori*, Buff Woodhen. According to Oliver (*New Zealand Birds*, 1930, 335), Strange obtained a specimen, or specimens, on the shores of Lyttelton Harbour "about 1850." On the 8th, after a stiff climb, Strange reached the summit of a high snow peak and got a view of wild and broken country. Without stating what they were he says he was disappointed in not getting the specimens he was in search of, so descended to his previous camp, the only "new" things obtained during the day being two species of *Lepidoptera*, three species of *Helix*, and a fern. On the 9th, continuing his return journey, his track passed through a gorge between two high mountains which he named Mount Acheron and Mount Stanley, "after the late Bishop of Norwich." Do these names persist to-day? He records finding a nest and five eggs of the Quail.

The next day he again reached the Deans Station. In the Hocken Library there is a collection of letters written by members of the Deans family. In one there is mention that "the exploring party have now returned."

On getting back to the Deans Station, Strange was annoyed to learn that Captain Stokes was leaving the ship for a 16-day trip to Mount Grey. He considered that he himself "could have reached the west side of the island in three days from the point from which I returned, and have ample time to spend a week on the west coast," had he not been on limited leave of absence, apparently due to the intended sailing of the vessel. He little knew the difficulties he would have encountered had he gone on.

Strange, however, joined Stokes on the 16-day trip to Mount Grey, catching up with the party at Riccarton. (23). In the newspaper article he mentions meeting with the flag, *Typha augustifolia*, or "raupo," and the native flax, *Phormium tenax*. He records seeing in most of the streams of the Middle Island five species of ducks, and notes that the Paradise Duck, *Casarca variegata*, was to be found chiefly on the plains and shingle beds of the larger rivers, while the "Red Bill," *Porphyrio melanotus*, or "pukeko" was to be found in all the swamps of the plains. He also mentions the wild pig, "mostly black, with a long tail and large tuft at the end," being plentiful and delicious eating.

After charting the east coast of Otago the *Acheron* went north and

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(23) W. G. McClymont, *The Exploration of New Zealand*, 1940.

charted the coasts of Cook Strait during May, 1849. At Tasman Bay, Strange collected a specimen of the Brown Creeper, *Finschia novaeseelandiae,* and gave it to Captain Stokes, who sent it on to the British Museum. (24).

From Cook Strait the *Acheron* went to Sydney to refit, arriving on November 1st, and Strange left the vessel.(25).

In the Mitchell Library, Sydney, there is an autograph letter from Strange dated from Sydney, February 24, 1850. The addressee, "R. Tailor, Esq.," is almost certainly the well-known New Zealand naturalist, the Rev. Richard Taylor, M.A., F.G.S., of Wanganui, he who discovered the bones and skull of the extinct *Aptornis,* which Professor Richard Owen named *Aptornis defossor,* and the author of *Te ika a Maui or New Zealand and its Inhabitants,* 1855

The letter is as follows:—

My Dear Sir,—

On my return to Sydney from my trip to the north of Moreton Bay I found your note of August 27, 1849, and where you kindly offer to get me some of the kiwi *Apterix australis* and asking me in what state I want them.

And now, dear, sir, this is the state I want the species in from your neighbourhood is thus, say six, in skins to consist of two females, two males and two young ones, and two adults, in brine, male and female, and some eggs if they can be got.

I have now some *Apterix* from the Middle Island, one species of which I sent home to England some three years ago. It is called after Professor Owen, *Apterix Owenii.* I am also anxious to get any species of land shells *Helix* or fresh water Unio from Wanganui. As I made a large collection in the *Acheron,* say about 100 species, and I give New Zealand about 360 altogether. But the finest species will be found down at the North Cape and, though I had no opportunity to go, and anything you can get send it on to Mr. Lyon, agent at Wellington, and he will forward it on to Sydney.

And, believe me, dear sir,

Yours faithfully,

F. STRANGE, Naturalist.

To R. Tailor, Esq.,—

If you are fond of shells I will make up a collection of the New Zealand L.F. land shells and forward you down, or our Australian shell land or marine, if you write me that you would like to get them—F.S.

The foregoing letter discloses that, prior to writing it, Strange had just returned from a trip to the north of Moreton Bay, so he must have set off for those regions very shortly after his return to Sydney from New Zealand. Entries in the *Catalogue* disclose that Strange was also in the Moreton Bay area between May 24, 1850, and July 28, 1851.

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(24) W. R. B. Oliver, *New Zealand Birds,* 1930, 477.

(25) The *Sydney Morning Herald* of November 2, 1849, gives information of the arrival of the vessel, and states that she "had two living kiwis on board."

A daughter, Martha Louisa, was baptised in Sydney on December 1, 1850.

Visit to England.

In 1852, Strange returned to England, accompanied by his family. They left Sydney in March, and the *Sydney Morning Herald* of March 9 gave his departure some publicity by publishing the following:—

"Natural History.

"To the lovers of natural history in this colony, it will be by no means surprising to see the name of Mr. Strange, formerly of Hunter Street, associated with new discoveries in the pursuit to which he has devoted himself. Mr. Strange has taken his passage on board the *Viemera,* for England, carrying with him a most interesting collection of specimens, collected by him during the last eighteen months in the northern districts of the colony. The district over which Mr. Strange's researches extend ranges from Mount Warning on the south to Briebie's Island on the north. The information which will be afforded by the collection of specimens will be highly useful to the cause of science, and at the same time will, no doubt, be peculiarly acceptable to the English public, as developing, by analogy, the various capabilities of this colony. Mr. Strange has a very elegant collection of ferns, amounting to sixty or seventy in number, many of which have been pronounced new. A splendid collection of crustaceous animals, including a large number of novel and interesting specimens. His entomological collection, too, presents much of beauty and interest, particularly exhibiting those species known to the naturalist in Africa and Asia, which inhabit the northern parts of this continent. Mr. Strange, we believe, intends to make arrangements to return to prosecute his researches in this colony, and we heartily wish success to so industrious a collector." (26).

On Strange's arrival in England, the *London Morning Advertiser* also gave him some publicity by publishing an account of him in the issue of June 24, 1852:—

"Mr. Frederick Strange, the naturalist, who is a native of Aylsham, in Norfolk, and who left this country several years ago for Australia, has just arrived in England from Sydney, New South Wales, per the *Viemera,* in ninety-four days, with a most valuable collection of specimens of natural history. Many of the botanical and entomological specimens are entirely new to the scientific world; and although the collection is so extensive, it has by no means been acquired without an immense amount of fatigue, danger, and perseverance, combined with ability and talent, in the selection, many of them hitherto unknown.

"They are the accumulation of the last three years' research; the tract of country explored has ranged in one direction from Mount Warning, on the south to Briebie's Island on the north of the colony, likewise over a considerable portion of New Zealand. Mr. Strange has been a resident in Sydney, South Australia, Moreton Bay, etc., for a number of years, but previous to the final adoption of his home in the New World, he

(26) Reprinted in "Literary Notices of the late Frederick Strange, Naturalist."

embarked in the third vessel which left the shores of England, in order to the formation of a new settlement in South Australia, where he remained twelve months prosecuting his labours in natural history, botany and in acquiring information relating to the resources of the colony.

"At this time he became acquainted with Mr. J. Gould, the celebrated ornithologist, who was engaged collecting materials for his admirable work on the 'Birds of Australia.' In the latter part of this year, 1839, he was engaged upon an expedition with Captain Sturt and Commander Pullen (who is now, or was recently, engaged for the search for Sir John Franklin) to explore the country north of the north-east angle of the Murray, during which the entire party nearly perished, being compelled to bleed their horses to quench their thirst, on account of the entire want of water. A very advantageous location being offered him in New South Wales, he left South Australia in 1841, and examined all the country from Cape Howe to Wide Bay, about 700 miles of the coast, and upon his return he took a nine (27) months' cruise in Her Majesty's ship *Acheron*, during which he visited Wellington, Auckland and the Canterbury Settlement. It may be remarked that he was the first white man who made the attempt to cross the Middle Island to the western coast of New Zealand. In his collection he has brought with him the only living specimen in Europe of the Gigantic Water Lily (*Nymphae gigantea*) (28), so elegantly described in the May number of Sir Wm. Jackson Hooker's botanical work."(29).

Amongst Frederick Strange's correspondence, made available by Mr. C. R. Strange, is an agreement drawn up at Norwich on September 17, 1852, by which " . . . Frederick Strange, of Australia, in consideration of the sum of one hundred pounds to be paid to him by John Thorold doth agree with the said John Thorold to divide equally with him all the profits for one year from the commencement of their operations; in whatever they may undertake on their arrival in Australia—fifty pounds of the said sum to be paid on or before the twenty-first of October next, and the remaining fifty pounds to be paid from the said John Thorold's share of profits, at the expiration of six months from the commencement of their operations."

The agreement was signed by John S. Thorold (30) and F. Strange, and witnessed by Trivet Allcock.

Just before Strange left England, the following note, communicated by Mr. S. Stevens, appeared in the *Zoologist*, Vol. 10, 1852:—

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(27) Actually exactly twelve months.

(28) Bot. Mag., t. 4647. "Several cultivators" in England had seed early in 1852 (Maiden, *Proc. Roy. Soc. N.S.W.*, 1908).

(29) *The Kilmarnock Journal* of the same date, and the *Norwich Mercury* of June 26, published what are virtually copies of the London article. Publication by the *Norwich Mercury* is understandable, as Strange was a Norfolk man, but the reason why the Scottish paper printed the account is obscure.

(30) John Thorold accompanied Strange back to Australia. There was, in 1855, a Richard Thorold, of Weelsby House, Lincolnshire, who had some connection with Australia, as his nephew, A. Grant, sent him two live emus from Australia. See *Naturalist*, 1855; 161-162. H. Thorold, Esq., was a subscriber to Gould's *Birds of Australia*.

"Mr. F. Strange,—This well-known Australian naturalist, who has been in England for some months, leaves in a few days for his old haunts, to further investigate the natural history of that great continent. Judging from what he has already done, and from his great zeal and activity, we may fully expect to receive many more novelties from him, which I will duly report, as they arrive, in the pages of the *Zoologist*."

Strange left London on October 27, 1852 (Plymouth, November 9, and Cape of Good Hope, February 7), on the *Resolute*. According to an entry in the family Bible, a son (31) was born on board whilst the ship was off the Cape on January 23, 1853. The arrival of the ship at Sydney on March 21, after a passage lasting 133 days, is recorded in the *Sydney Morning Herald*, and Mr. and Mrs. Strange and four children are listed as among the passengers.

Immediately on his return to Australia, no doubt, Strange busied himself in collecting and in supplying the wants of those naturalists with whom he had come into contact during his stay in England. One of these was the well-known Norwich banker and ornithologist, J. H. Gurney, as among Strange's correspondence is the following letter:—

London, February 13, 1854.

Dear Sir,—

I duly received your acceptable letter, newspapers, and a box of skins, together with invoice for the same, amounting to £20/9/6, for which amount I have the pleasure of enclosing a letter of credit in your favour on Messrs. Smith, Croft & Co., of Sydney—duplicate of which I intend also sending out a short time hence in case this should not come to hand in due course—I shall be very happy to receive the additional collection which you expect to send—including the nest and eggs of the Origma—I conclude by your having some expectation of being able to send a Notornis, that you think of visiting New Zealand, in which case I trust you may obtain not only the Notornis but also many other of the little known birds of that country—your last skins arrived in excellent order and without injury—I am especially engaged just now in examining the different species and plumages of the birds of prey both diurnal and noct(urnal) and would therefore especially call your attention to sending me birds of that order—I also shall be glad of shore birds and water birds as well as inland birds—but especially "birds of prey."

The letter was addressed to Mr. Frederick Strange, Naturalist, Norfolk Cottage, North Shore, Sydney, and bears a readdress to "Storekeeper," Sussex Street, Sydney.

There is, at present, little information regarding Strange's movements subsequent to his return to Australia. It is known, however, that he engaged in organising a trading and collecting expedition to the islands to the north-east, and a vessel, the ketch *Vision*, was chartered or purchased. Strange, at Sydney, on August 31, 1854, entered into an agreement with Joseph C. Rossiter and . . . Gordon Korff, whereby the three obtained interests, to the extent of 40, 8, and 16 sixty-fourths respectively, in a voyage to collect tortoise shell, oil, or any other produce, and to trade and

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(31) Baptised, Frederick Resolute, at the Old St. Thomas' Church, in North Sydney. Later to be Mayor of Mosman.

barter and to share equally in the proposition. As Strange was to proceed himself in the vessel and superintend the trading he was to receive a bonus of ten per cent. of the realised amount of trade and collections. The agreement, which is among the papers lent by Mr. C. R. Strange, was witnessed by John Korff. The following letter appears to show that Strange had written to England in an effort to get purchasers for any natural history specimens that might be collected on the expedition. Hugh Cuming was, of course, the well-known conchologist and London natural history dealer. The letter addressed, "Mr. Frederick Strange, Naturalist, 8 Bridge Street, Sydney," was endorsed "Favoured by Frederic Cuming." In an account of the son, Frederick Resolute Strange, in the local press, written when he became Mayor of Mosman, "8 Bridge Street," was described as a "quaint cottage, which stands high up on a rock on the corner of Princes Street and Crescent Street."

My Dear Sir,—

As I am about writing to my nephew Frederic Cuming, who will be in Sydney by the time this arrives, I thought I would write you again in answer to yours of July 14, 1854. Mr. . . . .? has applied to me to become a subscriber to your expedition, and I have put my name down of [for] one share of £50 for shells only, and I presume you have not started on it yet, as I hear from Mr. Stevens that you was at Moreton Bay. I hope you will get a few good things there, for it appears to me to be a fertile place and I think that if anyone can get anything good you are the man to do it and [k]now how to take care of them when you have got them. I got a few good things from Mr. Macgillivray from New Ireland, but Mr. Stevens received a quantity of the same kind of things from Sydney which lowared the value of them a good bit and I find there is a good many of the same things in other hands. Those were very pretty *Bulimi* and *Helix* and the straw coloured *Bulimi* has been described by Dr. Fieffer as *B. Strangei* and the *Helix* as *Eddystonensis* Reeve. You see, I do not forget you.

I received the money from Mr. Stevens for the bulbs sold Sir J.[torn]h Paxton. I have mislaid his letter wherein he gave it a name; everyone that purchased the bulbs have not succeeded in flowering of it, or even making it give out its foliage, except Mr. Van Houtte, of Ghent, who bought at Stevens auction one of the smallest bulbs and he has caused it to flower from the very smallest bulb of the lot. I was at Ghent, in August last, when it was in flower; it was of a beautiful light sky blue and about 3½ in. diameter, and by the account of Dr. Lindley, in the Botanical Register, it was about 12 inches over, and the accounts sent home by Mr. Bidwell. Luckily for you and me I have never been troubled with any more complaints from those gentlemen, who purchased them in England, as I hear from parties that they have all died, but I have been afraid to ask the parties themselves fearing they might make a claim.

I fear you will not get any plants from Standish Noble, for he and I are not freinds (*sic*) now, for he has threatened to bring an action against me for selling him things that would not grow, but he has been wise enough not to do it.

In the strictest confidence I write to ask you what Mr. Macgillivray is about in Sydney when there, for he has not sent home only one quarterly bill of £62/10/- since he has been away now nearly three years, and I have been supporting his wife by allowing her £6 a month besides other

incidental expenses. I fitted him out and with what I paid for him besides he now owes me £192, deducting the bill of £62/10/-, and what I have sold on his account, say £80 odd, what I have sold of his things he has sent me therefore by the time the letter which I am going to write him reaches him he will owe me more than £200, and if he does not send me money immediately he comes back to Sydney again I shall not advance his wife anything more and she and the children must go to the workhouse. You can show him this letter, but on no account let anyone know it besides himself. All what I have done has been for the sake of his wife and children. Their pitable state makes my heart grieve for them. I have not seen Mr. Macgillivray but thrice before I got him out of all his troubles and I have not had one-tenth part of the intercourse with him as I have had with you and I shall feel much obliged by letting me know the result of your communication with him. (32).

Cannot you get some seeds from the Island of Pines of that sort you had in your case when you came home . . . which I sold for 1/6 each; there were two or three growing in the case which I sold for £2 each; if Mr. Macgillivray had sent home a lot of these it would have paid all he owes me and more besides, but he did not send one when at the Isle of Pines. They must be packed in small boxes. One foot square and two feet long, one half seeds and the other half pure fresh water sand where a drop of salt water never reaches it. I hope you will see Frederic during the vessel's stay in Sydney.

With my kindest regards to your wife and great success in your undertaking.

I remain,

My dear sir,

Yours most sincerely,

H. Cuming. (33).

Strange was dead before that letter even left England and, doubtless, Frederic Cuming delivered it to the widow.

The *Vision* sailed from Sydney on September 4, 1854, and from Moreton Bay on the 29th, with the following on board: Strange as owner, with Richard Spinks as his assistant, George Elphinstone Vernon Maitland (master), William Spurling (mate), Geoffrey Geary and William Vann (seamen), and Henry Gittings (cook and steward). On board also was Walter Hill, who was described as a botanist, and who later became Colonial Botanist at Brisbane. It is not clear who started from Sydney and who joined the vessel at Moreton Bay, but a native named Deliapy was picked up at Moreton Island.

The *Vision,* after calling at a small island off Cape Capricorn, anchored off the Second Percy Island on October 14. Strange, Hill, Spinks, and the black went ashore the same day, but after remaining on the island for one

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(32) This reference to John Macgillivray should be read in conjunction with notes regarding him made by T. Iredale at the conclusion of the latter's paper, "The last letters of John Macgillivray," in the *Australian Zoologist,* 9, 1937, p. 40.

(33) (1791-1865), F.R.S., F.L.S. The letter is dated February 1, 1855.

hour returned to the ship. The next morning Strange, Hill, Spurling, Spinks, Gittings, and black went ashore again, unarmed, except that Strange had a double-barrelled gun. The gun proved an insufficient protection and Strange, Spurling, Spinks, and Gittings were killed by blacks.

Accounts of the murders appeared in the *Moreton Bay Free Press,* November 21, 1854, *Sydney Morning Herald,* November 21, and December 2, 1854, and *Empire,* November 21 and 23, 1854.

It is proposed to publish later the field-notes on birds entered by Strange in his *Catalogue,* but it may here be placed on record that he was the collector of the type-specimens of *Strix tenebricosa* Gould, 1845, Sooty Owl; *Podargus plumiferus* Gould, 1846, Plumed Frogmouth; *Menura alberti* Bonaparte, 1850, Albert Lyrebird; *Eopsaltria capito* Gould, 1854, Pale-yellow Robin; *Colluricincla rufogaster* Gould, 1845, Rufous Shrike-Thrush; *Ptilotis fasciogularis* Gould, 1854, Mangrove Honey-eater.

It is also proposed to publish an account of the mammals collected by him in Australia.

In conclusion, I desire to express my thanks to Mr. J. D. Somerville, of Adelaide, who has assisted me greatly in tracing the history of Strange in South Australia, and to Mr. C. R. Strange for kindly entrusting to me for perusal his grandfather's personal papers.

REVIEW.

Miss Joyce Allan, who has contributed to this journal (vii., 87 and viii., 261) two notable papers on the Nudibranchs—those beautifully coloured Sea-slugs of our coastlines—has recently produced, in the Records of the Australian Museum (xxi., 433), a further paper, "Nudibranchia from the Clarence River Heads, North Coast, New South Wales," which will interest our marine zoologists.

More than 30 species are discussed, some of them new to Australia. Many of them have a relationship with New Caledonia and other tropical places and occasionally stray down to Sydney Harbour. There are three plates of detailed illustrations and one new species, *Archidoris cameroni,* is named.

THE ZOO-GEOGRAPHICAL PROBLEM OF PORT JACKSON.

INTRODUCTION.—GENERAL PRINCIPLES.

PART I.—PHYSIOGRAPHY.

By CHARLES F. LASERON.

(Text figs. 1-2.)

INTRODUCTION.

GENERAL PRINCIPLES.

Before a detailed study of the marine ecology of any locality can be commenced, certain broad principles must be considered. Any or all of these may be the determining factors in the ultimate result; yet their influence may not at first sight be apparent. These main factors may be considered under the following headings:—

(1) Physiography—both recent and past.
(2) Temperature.
(3) Salinity.
(4) Light and pressure.
(5) Nature of bottom.
(6) Continuity of conditions.

Physiography: While the present geography of a region has a great bearing on the nature and distribution of its flora and fauna, changes which have taken place in the past must not be overlooked. The crust of the earth is anything but stable, and earth movements are continually taking place. Elevation and subsidence not only affect the depth of water, but open or close avenues of migration from one locality to another.

Drainage from the land is diverted, rivers disappear, new ones appear, considerably affecting the salinity of the sea water in the vicinity of their outlets. Denudation of the land is increased or decreased, and the volume and nature of water-borne sediment is altered.

With all physiographical changes, corresponding changes take place in the distribution of life, but there will be some survival of original biological elements, as well as the introduction of new. It is in the study of the past, therefore, as well as the present, that the solution of any given zoological problem will be found.

Temperature: Generally speaking, the temperature of the sea is much more uniform than air or surface temperatures on the land. The chief factors controlling it are:—

A. Latitude.
B. Depth.
C. Ocean currents.
D. Winds.

It is a general principle that the temperature of the sea decreases according to distance from the equator and depth from the surface. But

this is greatly modified by ocean currents and convection currents caused by prevailing winds and storms. At even shallow depths there is little diurnal or even seasonal variation and, moreover, the temperature will be nearly constant over considerable distances.

Temperature is an important factor in delimiting the main zoogeographical provinces, but is not so important in determining ecological communities within them.

Salinity: Marine animals are extremely susceptible to any change in the salinity of sea-water. In the open ocean the salinity is remarkably uniform throughout the world. It is only in certain areas adjacent to the land that it is subject to much change. Here, therefore, the nature of the rivers flowing into the sea is very important. It may be laid down that a larger river with a uniform flow will have less effect than a smaller river subject to sudden and violent flooding.

Conditions in or near the estuary of a river may be otherwise ideal for a large marine biological community, but a periodical large flood is so destructive that such a community is never established.

Light and Pressure: The depth to which light penetrates into sea-water and the increase of pressure with depth are important factors in the distribution of life in the ocean. Light is necessary for the existence of plant life, which in turn is the basis of animal life. The penetration of light into water varies according to the strength of sunlight and the clearness of the water. The vertical sun of the tropics will penetrate deeper than the oblique sun of high latitudes, but even in the tropics the great mass of the ocean lies within the zone of perpetual darkness.

Pressure, too, is a factor in distribution, but it is remarkable what extreme limits of pressure many animals can withstand, particularly if transition from one pressure to another is gradual.

It is not possible to lay down a hard and fast sub-division of the sea into depth zones, as deep water life merges gradually with that of shallower water, but for convenience zones can be defined within broad limits as follows:—

A. The foreshore—that is, the area of land between extreme high and low spring tides.
B. Low water to 5 fathoms. Subject to wave action.
C. 5 to 20 fathoms. Sunlight penetrates freely.
D. 20 to 50 fathoms. Twilight only.
E. 50 to 300 fathoms. Light very dim.
F. Below 300 fathoms. Perpetual darkness.

Nature of Bottom: The nature of the sea bottom can and does vary very rapidly within even a limited area, and has a tremendous effect on the distribution of life. The volume and variety of living forms will depend mainly on two factors:—

A. Food.
B. Shelter.

Food: The basis of all animal life is vegetation, whether on land or sea. In the sea, in addition to fixed algae, which are confined to comparatively shallow water, adjacent to the land, microscopic plants, chiefly diatoms, abound in all surface waters of the globe. Diatoms are the basic food of

most marine animals, directly with some, indirectly with others. Near the land, food supply is augmented by the decay of terrestrial vegetation washed into the sea. Where vegetable life is abundant, there animal life will also be profuse.

Many animals feed directly upon sea-weed; others by means of siphons or cilia extract nutriment from organic matter in the sea itself. Following these come the carnivora which prey on the vegetarians or on other carnivores. Practically no part of the sea is absolutely deficient in food; even in the abysmal depths there is a continual rain of dead matter from the surface; consequently some animal life is nearly always present. But certain types of sea bottom provide food in abundance, and these are prolific, both in variety and number of individuals.

Shelter: Most species need shelter of some kind, either as protection from enemies or from adverse physical conditions. On land, shelter is needed from the heat of the sun, from the cold of night or winter, from flood or drought. In the sea adverse conditions might rise from waves or currents, or from drifting sand or mud. Shelter from predatory enemies may be by concealment or by the development of thick shells or spines. Concealment may be within rock cracks or crevices; it may be had by burrowing, or it may be by protective colouring or other camouflage, or by the emission of clouding fluids into the water itself. The nature of the sea bottom has a varying effect on all these characters.

A convenient classification of types of sea bottom, each with certain biological characteristics, is as follows:—

A. Rock.
B. Coral.
C. Sand.
D. Sandy mud.
E. Mud.
F. Weed.

Continuity of Conditions: When conditions are maintained over a considerable period a certain stability results, and a stage is reached when there is little change in the life of an area. Normally, when a species fails to conform to its environment, or when the environment changes too rapidly it becomes extinct, either entirely or in that particular area. It may not be prolific enough to keep pace with the depredations of its enemies; it may not be able to withstand such physical changes as occur; it may not be able to compete with other forms requiring the same food; it may be overcome by disease. If it survives for any great period it will be only by maintaining a balance with neighbouring organisms. Mutual dependence is, in fact, the keynote of survival. Even too great a success may bring disastrous results. A predatory animal, by hunting too successfully may destroy all its game, until it too cannot find enough food to survive. The prey also may protect itself too efficiently and by multiplying too fast destroy all the vegetation on which it depends for existence.

When, however, a proper balance is attained, and when conditions remain uniform, a stage is reached in which each species, botanical and zoological, unwittingly plays a communal part, and not only depends upon, but contributes its share to the common weal. Such an assembly is an ecological colony, and the study of the mutual relationships within it constitutes the Science of Ecology.

PART I.

Physiography and Origin of Port Jackson.

The Coastal Subsidence.

It has long been accepted that many of the harbours on the coast of New South Wales, including Broken Bay and the estuary of the Hawkesbury River, Port Jackson, George's River and Port Hacking are drowned river valleys. This has never been challenged, though there has been a considerable divergence of views as to the sequence of events which led to their inundation by the sea. The earlier geologists generally agreed that there were two major tectonic movements, one the uplift of the coastal plateau in late Tertiary times, and subsequently a subsidence with faulting on the eastern edge of the plateau. There is evidence of both these movements, though the possibility is that, instead of being separate, they were simultaneous and were part of a general crumpling of the eastern edge of the continent, accompanied, not only by faulting, but by the production of north and south troughs which greatly changed the nature and direction of the coastal drainage.

In recent years another factor has been admitted into the scheme of things. Research by many writers into the Pleistocene Glacial and Inter-Glacial Periods has shown that these phenomena were not confined to limited areas in the Northern Hemisphere, but were world-wide in their effects. Not the least of these effects were the changes in relative sea level caused by the melting of continental ice sheets in the warm intervals between intense refrigeration.

In a recent presidential address to the Linnean Society of New South Wales, Dr. W. R. Browne has given a masterly summary of such research to date, particularly as it applies to the continent of Australia, and has reviewed the evidence in a way that greatly facilitates the detailed study of its application to a local problem. So much so that the need is obviated to traverse again the extensive literature, and it is proposed to follow his chronology and other conclusions as a working hypothesis in tracing the origin of Port Jackson and its marine fauna. For the purpose of this paper, therefore, we may accept certain deductions as a basis on which to build. These are as follows:—

(1) That in late Tertiary times, much of New South Wales consisted of a peneplain, subject to a cold moist climate.

(2) That tectonic movements took place leading to the elevation of the tableland and subsidence of the coast. These movements were gradual and continued well into the Pleistocene Period.

(3) Throughout the Pleistocene Period there were several glacial and inter-glacial periods. Following the last glacial epoch, the climate became warmer, not only in Australia, but throughout the world, and there was a general melting of all glacial ice sheets.

(4) That with the melting of the ice the level of the ocean was increased between 200 and 300 ft.

(5) That this terminated the Pleistocene Period and ushered in the recent period, approximately from 5,000-15,000 years ago.

(6) That within recent times there have been minor changes and the

coast has either risen from 15 to 20 ft. or the sea level has fallen due to a colder climate and reglaciation. Other changes have been a process of dessication in Australia, with the extinction of many species of giant marsupials.

The Peneplain: The peneplain stage marks the birth of Port Jackson and other harbours, which might be said to have taken place when the original streams first started cutting channels through the surrounding rocks on their passage to the sea. The peneplain was not at this stage right at base level. Probably there had been some elevation, the incipient stage of the great orogenic movement of the Kosciusko uplift. Consequently there was some rejuvenation of the streams and erosion took place. The height of the country thus drained can be judged by the depths of the valleys, and may be taken as from approximately 600 to 900 ft. The depth of Port Jackson from the summits of the surrounding hills to bed rock is from 500-550 ft; that of the Hawkesbury considerably more—over 900 ft. Either the land was somewhat higher or the Hawkesbury, being a larger river, cut its bed more rapidly.

It is doubtful if Port Jackson ever contained a considerable stream. The Hawkesbury to the north and the Shoalhaven to the south drained the greater part of the hinterland, and Port Jackson was but one of many minor streams between. This peneplain stage was one of quiescence, during which the coastal streams cut their valleys to or nearly to base level.

The Blue Mountains: Following the peneplain stage came the building of the Blue Mountains and the general coastal subsidence. It is possible that even in the previous stage altitudes were somewhat higher back from the coast, but there seems little doubt that considerable elevation now took place simultaneously with the coastal subsidence.

In seeking a guide to comparative changes in land level in the vicinity of Port Jackson, a good clue is the Hawkesbury sandstone, for not only does it cover a large part of the area, but at the time of its deposition it must have been practically horizontal. It probably also lay undisturbed for a very long period at or near sea level, and changes of level which have taken place are of comparatively recent date and associated closely with existing topography.

No definite horizon in the sandstone can be taken, as the formation is in places over 1,000 ft. in thickness, and is remarkably uniform throughout. A horizon available for comparison in some localities is the base of the sandstone, at its junction with the Narrabeen Beds. More apparent and easily observed is the top of the sandstone, though this may be misleading when lowered by erosion. Where the Wiannamatta Shales overlie the sandstone this horizon is defined, but again allowance must be made for the fact that much of the Wiannamatta Shale lies in hollows in, rather than completely above the sandstone.

Using the base of the sandstone, we can take this at sea level at Narrabeen, six miles north of Sydney Heads, at 890 ft. below sea level, in the No. 1 Cremorne bore, at 994 feet below sea level at the Balmain Colliery, at about 2,800 ft. above sea level at Mt. Victoria, 60 miles west of Sydney, and at about 1,500 ft. above sea level the same distance to the south. On the coastal plain between Sydney and the Blue Mountains the sandstones are overlain by the Wiannamatta Shales, so that their full thickness is below

them, but in the Penrith bore the Narrabeen Beds were reached at 825 ft. below sea level.

These comparative levels indicate that the depression in which Port Jackson lies is not so much a half basin open to the east as a true basin. In this a north-south section shows a nearly perfect syncline, while a west-east section shows an asymmetrical syncline, with a steep and high western margin, while the eastern margin rises from about the vicinity of Parramatta gradually towards the coast.

This conforms generally with north and south trough folding on other parts of the coast of New South Wales.* One of its effects has been the formation of a coastal ridge in many places, with lower land behind, and the beheading of many coastal streams, the drainage being diverted into rivers flowing parallel to the coast, such as the Hawkesbury and the Shoalhaven.

This subsidence has generally been accepted as that which plunged the river valleys beneath the sea, but in view of the fact that the eastern margin of the basin remained at a higher level than the centre of the trough, the subsidence here would not be very great, and the probability is that the valley floors still remained slightly above sea level. One striking effect of the backward tilting would be to practically level the valley floors, and eliminate their previous easterly fall, or even reverse the fall to the west, so that they became deeper in their western recesses. (See Fig. 1.)

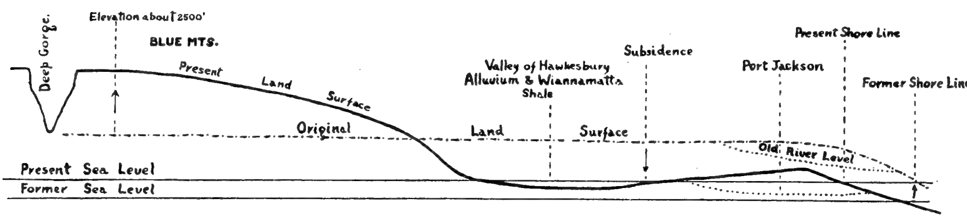

Fig. 1.—Diagrammatic Section, Blue Mountains to Sydney, showing how folding produced elevation in the west, with subsidence in the east and a central trough. At a later stage, the rising sea level inundated the river valley.

Substance is given to the hypothesis that the folding was all part of one movement by the much greater depth of the Blue Mountain gorges than the drowned river valleys on the coast. The latter are at the most some hundreds of feet in depth, while the gorges on the mountains are in many cases over 2,000 ft. This suggests that the eastern part of the original plateau was never elevated to the same height as the western, and has thus not been subjected to the same intense erosion. An elevation of the Blue Mountain tableland at the same time as the coastal subsidence would produce intense rejuvenation of the river systems, with rapid dissection of the tableland and the production of deep gorges as at present exist.

The Final Submergence: Following the folding a period of quiescence

*C. Hedley. "Presidential Address," Proc. Linn. Soc., N.S.W., 1911.

followed, during which there was but little erosion on the coastal ridge, but continual deepening of the gorges of the Blue Mountains. The main drainage from the mountains still found an outlet through the Hawkesbury Valley, which had always been deeper than Port Jackson, and which now captured the head waters of streams far to the south. Port Jackson at this stage was practically a dead valley, nearly level, at, or slightly above sea level, and was probably covered with swamps. In the last stage of the folding it might even have been subjected again to a slight elevation, with some rejuvenation of drainage and a small renewal of erosion. There is some evidence of small secondary valleys within Port Jackson and George's River which could have been thus excavated.

There is no means of measuring the duration of this period of quiescence, but it lasted throughout the closing stages of the Pleistocene Period, during which there was a world-wide warming of climates and a partial if not total melting of alpine and polar ice. Evidence has been accumulating of the gradual rise of sea level during this period, a rise estimated in Europe at between 200 and 300 ft. and given by Browne for Australia at approximately 260 ft.

It was this rise that finally inundated the coastal valleys of New South Wales and portions of the coast.

Botany Bay: Just south of Port Jackson lies the extensive sheet of shallow water known as Botany Bay. In a north-south section of the main subsidence basin the lowest point may be taken as in the vicinity of the western shore of the bay. As in Port Jackson, there is a rise to the east from this point, leaving the land on the margin of the basin somewhat higher and forming a ridge on the seaward side. It is probable that the initial subsidence allowed a partial inundation of this area with a subsequent slight elevation above sea level again. There is abundant evidence in bores within the area of shallow water marine deposits overlaid with peat beds and tree stumps in situ. The marginal ridge now forms the eastern shore of Botany Bay, and a gap through it is the present entrance to the bay. Another gap evidently existed in the vicinity of Cronulla on the south side, but became closed in the same way as the southern entrance into Port Jackson at Bondi. This will be referred to later.

The final submergence of Botany Bay came like that of Port Jackson with the general rising of the sea itself but, unlike Port Jackson, Botany Bay is a submerged tract of land and not a drowned river valley, though George's River which enters it in its south-western corner has the same river valley characteristics as Port Jackson, and Port Hacking a little further to the south.

The Origin of Port Jackson.

Prior to the final rising of sea level, the coast line probably lay some miles to the east of its present position, and the sea had probably penetrated some distance into the mouths of the coastal streams. Given a rise in sea level of 250 ft., and the average depth of the harbour at final submergence as 150 ft., the original strand line would be some 100 ft. below the level of the harbour bottom. Smith and Iredale* have advanced evidence of an original strand line at a depth of 400 ft. right along the southern

*Jour. Royal Soc. N.S.W., 1924.

portion of the coast of New South Wales, but this evidence is open to considerable doubt. It consists of sandstone blocks of recent origin brought in by trawlers from this depth, the sandstone containing sub-fossil shells, which the authors claim as littoral and similar to those found close to the beaches at the present time. No account has been taken, however, of the extensive sedimentation which must have occurred in the interval since submergence, amounting to upwards of 90 ft. within the harbours, and probably as much, or more, on the continental shelf. Moreover, the shells listed are by no means typically littoral, the most characteristic beach forms such as *Donax, Mactra* and *Cantharidus* being conspicuous by their absence. Such shallow water forms as are included are those which have an extensive range in depth: for instance, *Pecten meridionalis,* or at least its New South Wales relation, *P. medius,* occurs alive to at least 30-35 fathoms off the coast. Others listed are, in fact, typical continental shelf shells and are abundant to depths of over 80 fathoms, and are rarely, if ever, found on the beaches. Amongst these are *Cardium pulchellum, Marginella kemblensis, M. mayii, Friginatica beddomei, Estea bicolor,* and others. For these reasons this definite location of the former strand line cannot be taken as proved, and its position can only be deduced from the general evidence.

Once the valleys passed below sea level there would be a rapid inflow of sea water, producing long, winding inlets, with a fairly uniform depth, or even occasionally deeper at their western extremities. The flooding ceased when the harbour bottoms were from 150 ft to 200 ft. below the level of the sea.

Slow sedimentation has subsequently reduced this depth in Port Jackson to an average of about 60 ft., so that the accumulated sediments average about 90 ft. in thickness. This sedimentation must have been extremely slow. If the hypotheses previously outlined are correct, the period of deposition would approximate to that of the deepening by river action of the gorges of the Blue Mountains, possibly by upwards of 1,000 ft.

Slow sedimentation might be expected in Port Jackson. No streams of any size empty into it; indeed, it is doubtful if it ever contained a large river, or one draining any great area of country. Prior to settlement, also, most of the drainage from the surrounding hills would be effectively sifted by the dense vegetation, and very little silt would be washed into the harbour.

It is difficult to give any direct evidence of the time so involved. Observations by the Maritime Services Board, based on resedimentation of dredged channels, for a while led to an estimate of one inch per year, but it is now recognised that this was due more to the temporary redistribution of existing sediments by tidal currents, than to new sedimentation.

Certainly in the period of the white man's occupancy there has been no discernible shallowing of the water. Unfortunately there has been no controlled record to check the depth in any fixed spot, and the only evidence is by comparison of the first charts with those of the present time. This is not altogether satisfactory, as not only is it impossible to pin point any one locality, but there is no proof that both are measured from the same datum line. With this in mind, the following comparative table is not to be taken as in any way conclusive. The figures given are for the greatest depths in limited areas, and are taken from Capt. Freycinet's Atlas of 1812, and the latest charts available, thus giving a period of a little over 100 years.

	1812.	Present Charts.
	Depth in Feet.	
Middle Harbour, above Spit	96	Over 100
North Harbour, due west of Quarantine Point, centre of Channel	54	50-60
To side of Channel	42-48	40-50
Main Harbour, off Bradley's Head	60	Over 60
North of Pinchgut	60	Over 60
W.N.W. Bottle and Glass Rocks	102	Over 100
Above Bridge	138	150

These figures suggest that in the time involved the harbour has actually deepened slightly rather than silted up, but it is not asserted that the figures are accurate enough to warrant this conclusion. But I think they do warrant the assumption that sedimentation is so slow that in 100 years it has made no perceptible difference in depth.

If glacial chronology be accepted, and the final submergence be taken as at the close of the Pleistocene Period, from 5,000-10,000 years would be an approximate estimate.

Two separate valleys: So far, Port Jackson has been considered as a whole; actually there seem to have been two separate river valleys with separate outlets to the sea.

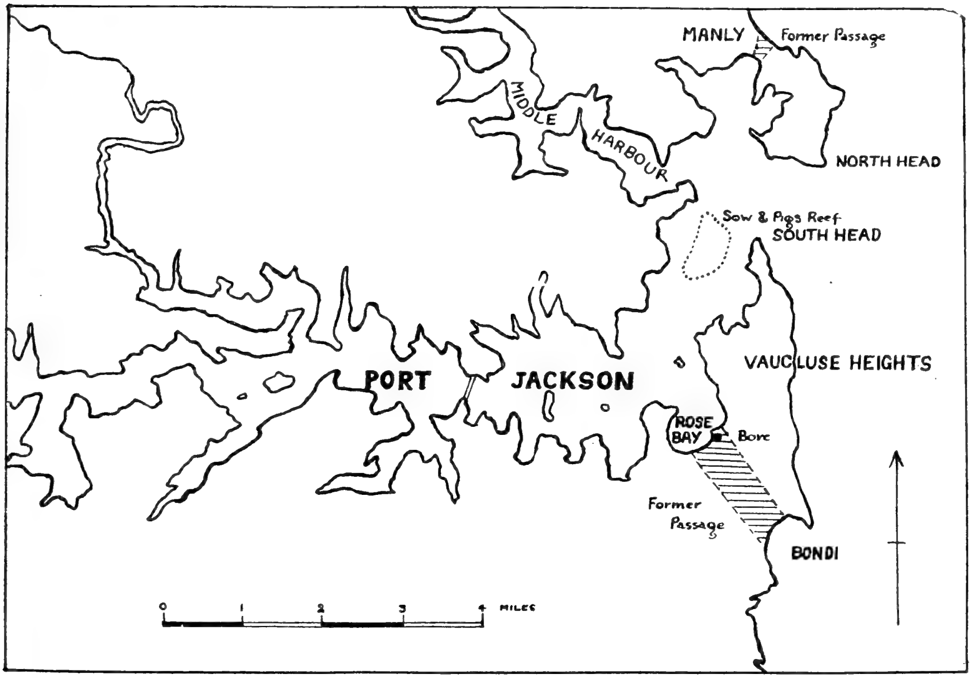

Fig. 2.—Port Jackson, showing relative positions of Sow and Pigs Reef, and original outlet of main harbour between Rose Bay and Bondi.

Looking at the map (Fig. 2), one of these valleys is now occupied by Middle Harbour, and it entered the sea between the present heads. The other valley, now the main harbour, was separated from this by a low col, now Sow and Pigs Reef, joining higher land from George's Heights, in the west to Vaucluse Heights in the east. The outlet of this stream was through the gap between Bellevue Hill to the south, and Vaucluse Heights to the north. This low lying land, connecting Rose Bay with Bondi Beach, is now a golf links and residential area, but was previously covered with sand dunes and small swamps.

In seeking evidence to decide this question, a great deal depends on the comparative depths of bed rock at Sow and Pigs Reef on the one hand and between Rose Bay and Bondi on the other. In comparing these two former land levels, the backward tilting of the land must not be overlooked, but the effect of this is not likely to be great, for the two localities are only about two miles apart, and both lie on the strike of the folding, which would keep their relative levels the same during subsidence.

Sows and Pigs Reef: This is a prominent feature of the harbour and the keynote of much of the investigation. It lies right athwart the channel, rising in rocky outcrops to sea level in the centre, but consisting for the most part of a bank of sandy mud, exceedingly rich in marine life. In the early days of settlement, there was only a depth of about 20 feet of water on the bank, but now both east and west channels have been dredged to 45 feet. Actual dredging has scooped holes somewhat deeper than this without reaching rock, but there is some evidence that bed rock lies not very far below the lowest point reached.

Dredging by the harbour dredge "Triton" in the east channel passed through solid firm sand, with a great variety of interesting and at times exotic tropical shells, but, more significant, quantities of coral of a reef building type. This must have grown on rock, and, of course, may have been washed from the rocky sides of the channel, but its condition suggested that it was very nearly in situ, and bed rock was at no great depth below, say, 70, or at the most 80 feet from the surface.

Recent dredging in the west channel at depths of 40 to 50 feet show the sediments to be very coarse, with much broken rock. This material again may have been washed from the channel sides, but is also suggestive of rock at no great depth. In fact, unless a river channel lies in a very narrow gorge, the whole configuration of the reef suggests that it forms a continuous ridge connecting the high land on either side, and at a maximum depth of between 60 and 80 feet below present sea level.

Rose Bay: The ultimate depth of sediment in the gap between Rose Bay and Bondi is not yet known. A few bores have been sunk in search for water, the deepest until recently in the Rose Bay Golf Links, one of which reached 91 feet without bottom. This would give an effective depth of over 80 feet below low tide level.

Now, owing to the courtesy of Mr. Royal, boring contractor, my attention has been called to a bore on the reclaimed land at Lyne Park, Rose Bay, and a visit was made to the site while boring was in operation, and marine specimens obtained from a depth of from 75 to 95 feet. This bore has since been bottomed on sandstone at 148 feet, or 143 feet below high tide level. The following is a summary of the section supplied by Mr. Royal:—

		ft.
	Filling, sand, etc.	14
	Grey sand and shells	16
	Brown sand	15
	Sandy clay	5
	Grey sand	16
	Grey clay	1
	White sand	4
	Black clay	2
(a)	Black mud and shells	20
	Grey sand and shells	2
	Grey sand and clay	13
	Mud and shells	10
	Soft shale	10
	Coarse grey sand	20
	Sandstone	2
	Total	150

Samples of consolidated black mud from the horizon at (a) were washed and sifted, and a number of recognisable fragments and some whole shells were obtained, from which the following species have been identified:—

Arca trapezia, Deshayes; *Brachyodontes hirsutus,* Lamarck; *Chlamys* sp., fragments only; *Cuspidaria* sp., fragments only, showing hinge; probably new like *C. brazieri,* but with coarser sculpture; *Antigona striatissima,* Sowerby; *Solen correctus,* Iredale; *Spisula trigonella,* Lamarck, very abundant; *Liotia micans,* Adams; *Obtortio lutosus,* Hedley; *Pyrazus australis* Quoy & Gaimard; *Ringicula* sp., a new species, identical with *R. doliaris,* except for a strong tooth within the outer lip, 4 good specimens; *Nassarius tasmanicus* Ten. Woods, common; identical with, but somewhat smaller than the species at present inhabiting the harbour; *Aclis* (?): an unidentified species, distinct from any form recorded from New South Wales. Mr. Iredale suggests that it may be related to *Eulima,* and recalls some forms from Antarctica, but further research is necessary to establish relationship. Four specimens, somewhat worn.

From such a small amount of material this is a considerable variety, enough to show that it is part of a large fauna. The species are for the most part identical with those now living in the adjacent waters of Port Jackson. The one or two exceptions are interesting, and possibly significant, particularly as the existing molluscan fauna from this type of habitat has been well studied. Data are at present insufficient to generalise, but lines for further research are indicated to discover: (1) What species have become extinct since the harbour was submerged? (2) Did these extinct species belong to Antarctic forms which disappeared as the climate became warmer during the melting of the Polar ice sheets?

The alternation of sand and mud in the bore is also interesting. The fine black mud is similar to the sediments at present forming in the more sheltered part of the harbour. It is probable that the two thick layers of mud were formed during temporary pauses in the eustatic movement which filled the harbour, during which bars formed at the entrance. Behind the bar were quieter waters in which finer sediments were deposited and a mud fauna existed.

Though the depth of 148 feet to rock bottom, or 143 feet below sea level, is slightly less than in the vicinity of the harbour bridge, it is appreciably greater than the probable depth of rock bottom at Sow and Pigs Reef.

If so, the original line of drainage was in this direction. The exact position of the original channel is unknown, but both this bore and the 91 feet bore lie to the north of the centre of the gap, and others a little farther to the north have bottomed at from 30 to 40 feet. This suggests that the main channel is somewhat to the south, probably from 100 to 200 yards, and that it is still deeper, in the vicinity of 200 feet. It must then have carried the drainage to the sea through what is now Bondi Beach.

It is possible, of course, that the streams of Middle Harbour and Port Jackson even then united before they entered the sea, but in this case the junction would have been somewhere to the east of the present South Head, and not within the present limits of the harbour.

Reconstruction of Events: Trying to form a picture of conditions as they were when the subsidence took place, we see a general plateau with a height of from 700 to 1,000 feet, extending over much of the eastern portion of New South Wales. Moisture from the prevailing sea winds was more widely dispersed in the interior and there was a moister and possibly warmer climate. This has been accepted by most geologists.

In the vicinity of Port Jackson two streams cut fairly deep valleys eastwards to the sea. Large earth movements began, resulting in a fold, with subsidence in the east, elevation in the west, and the formation of a central trough, tilting the land backwards until the bottoms of the valleys were nearly level. Following the subsidence, eustatic movements raised the sea level, and it entered both valleys simultaneously and filled them to their farthest limits. North Head became an island. For a short space there were two harbours; then, as the waters still rose, they flowed across the col at Sow and Pigs Reef, and there was one harbour with two main openings, Vaucluse Heights lying as an island in the centre.

Even more marked in its influence than it is at present, the Notonectian current played a large part in the distribution of marine life in the vicinity, and also had an effect on further physiographical changes. This current is the persistent tropical current which still flows down and impinges on our coast from the north.

Pressing into the harbour through the gaps at Manly, and between the present heads, it would flow across Sow and Pigs Reef, and out through the gap at Bondi. This current would carry with it the larval forms of many tropical marine animals, molluscs and corals among others. Many of these came to rest in the shallow waters of Sow and Pigs Reef. Conditions here would be favourable for coral growth; not only the warmer climate, generally, but clear, warm water, continually replaced by the inflowing tropical current. It was at this stage that the corals in the east channel flourished, as did the many tropical shells found in the "Triton" dredgings.

The current pouring through the southern gap would meet the Antarctic current coming from the south, as well as incoming tides and heavy seas at times from south-easterly gales. At first a bar would form, to be gradually raised to sea level. The final small elevation would assist in turning the bar into dry land, and wind-blown sand formed the dunes at Bondi, as they existed a few years ago.

The gap at Manly filled in a similar manner, leaving the harbour with only one entrance, as it is at present.

Conditions would now deteriorate for the growth of coral. The reduction in volume of fresh sea water flowing continuously across the reef would restrict growth, as would the gradual cooling of the climate, and the deposition of fine mud and sand in the stiller water would finally kill it off. Not entirely so, for there is still living in Watson's Bay, just below low tide level, a mass of reef building coral, many feet in diameter. Some of the tropical shells also still persist; for instance, *Strombus luhuanus,* and others which may still be found at Bottle and Glass Rocks in the near vicinity.

The final stage was the slow sedimentation of the harbour. In the upper reaches of both the main and middle harbour, the sediment consisted mainly of very fine silt, which sank to the bottom as soft mud. With the exception of a few patches of sand this covers most of the bottom above the Spit in Middle Harbour, and above Bradley's Head in the main harbour. Near the Heads, wave action has produced sand from the erosion of sandstone, and here much of the bottom is pure sand with its characteristic fauna. On banks such as the Sow and Pigs, a mixture of sand and mud produced a bottom extremely favourable to marine life, and here is the most prolific fauna, both numerically and in variety of species. A few higher ridges still remain as islands, but except on their fringes, and adjacent to the shores, there are practically no rocky reefs.

The last change of any importance, apart from slow sedimentation, has been the raising of the shore line to the extent of from 15 to 20 feet. This may have been due to an actual elevation, or by a recession of the sea, caused by a chilling of the climate and a certain amount of reglaciation. An argument against the latter hypothesis is that in Antarctica, particularly, there is evidence that the ice sheet has shrunk slightly in recent times rather than grown, pointing to increasing rather than decreasing temperatures. It can be taken that in Australia at the close of the Pleistocene Period the climate was definitely moister than at present, and this alone would be sufficient to account for the greater area of rain forests and for the existence of the giant marsupial fauna.

Evidence of the slight rising of the shore line exists in the form of numerous raised beaches along the coast.

It also played its part in the closing of channels into the harbours, such as at Manly and Rose Bay, into Port Jackson, and at Cronulla into Botany Bay.

In other places the plane of marine denudation was elevated above sea level, and the shore line set backwards as much as a mile from its original position. In many places, such as Narrabeen and Lake Illawarra, sand banks have accumulated and have isolated former parts of the sea into shallow land-locked lagoons. Former rocky islands have also become merged with the coast as at Narrabeen and Newport, and channel or channels into Pittwater have become closed. These changes have, all within their limits, affected the habitat of many marine animals, the reefs and sandy bottom of the open sea being replaced by mud or by the specialised conditions of the mangrove swamp.

Distant Physiographical Changes.

These must not be overlooked in their effect on the distribution of life in the more limited area under review, particularly in the changes wrought on the direction of ocean currents, warm or cold, and in the opening or closing of channels of migration.

The most apparent has been the severance of Tasmania from Australia and the production of Bass Strait, which was apparently finally contemporaneous with the final flooding of Port Jackson. This has been dealt with by Hedley, and its effects on the New South Wales marine fauna extensively reviewed.

Not so apparent, and as yet largely unexplained, is some connection of the N.S.W. fauna with that of New Caledonia. The presence of the Britannia Ridge, some 60 miles east of Southport, southern Queensland, which rises from the abyss of the Tasman Sea to within 220 fathoms of the surface is a possible factor in some of these problems, as is the growth of the Great Barrier Reef, and its possible effect on the Notonectian current. There is a strong tropical element in the New South Wales fauna as far south as Shellharbour, 60 miles south of Sydney, and there is some evidence that this element has waxed and waned over a period of time, a fact no doubt connected with physiographical changes on the coast of Queensland itself.

On these matters a great deal of further research is necessary, and it it is hoped to deal with them to some extent in Part II of this paper at a later date.

REVIEW.

Catalogue of the Cerambycidae (Coleoptera) of Australia, by Keith C. McKeown, F.R.Z.S. *Australian Museum Memoir,* x., May 2, 1947, pp. 1-190.

The family Cerambycidae, or Longicorn Beetles, is a large one and of considerable economic importance to those in whose hands lies the care and welfare of our forests, as many of the species attack trees, tunnelling extensively in the timber. To all workers on Coleoptera—or beetles—this Catalogue, embodying as it does the results of many years of specialised work, should prove invaluable, listing the Australian species known up to the date of publication, with full references to the extensive literature in which each is described and discussed. The present Catalogue is the first, with the exception of one by F. P. Pascoe, published in 1866-67, to deal solely with the Australian species of the family. When George Masters included them in 1885-87, in his Catalogue of the Described Coleoptera of Australia, they numbered only 547 species; to-day 1,060 species are listed. In addition of listing all references, the present work includes a number of features not usually included in such a Catalogue; references are given to the recorded host-plants and parasites, and to the location of the types, where it has been possible to ascertain these with any degree of certainty. The food plants of less than 100 species of these beetles have been recorded, which provides striking evidence of the lack of field research carried out in the past on this important group of insects.

NEW SHARKS AND FISHES FROM WESTERN AUSTRALIA.

PART 3.

By G. P. WHITLEY.

(Plate xi. and text-figs. 1-3.)

In continuation of this series, the following nuncupative and descriptive notes were prepared during my field work in Western Australia for the Division of Fisheries, C.S.I.R., in 1945. There aboard the ketch *Isobel* I travelled from Fremantle to Derby and back to Geraldton, visiting various islands en route, and collected fishes, shells, etc. The present paper is purely incidental to the main purpose of that voyage which was to identify surface fishes (especially Clupeidae and Scombroids) to which we were usually directed by aeroplane and two-way radio.

By trolling with bone jigs, feather lures, rags, etc., 16 different species of fishes were caught during the *Isobel* cruise in July-December, 1945. Some were new to the Western Australian fish catalogue. In order of first capture they were:—

1.—Southern Bluefin Tuna . . . . *Thunnus maccoyii* Castelnau, 1872.
2.—Striped Tuna . . . . *Katsuwonus pelamis* (Linné, 1758).
3.—Yellowfin Tuna, *Neothunnus macropterus* (Temminck & Schlegel, 1844).
4.—Samson Fish . . . . *Seriola hippos* Gunther, 1876.
5.—Northern Bluefin Tuna . . . . *Kishinoella tonggol* (Bleeker, 1851).
6.—Large-scaled Tunny . . . . *Grammatorycnus bicarinatus* (Quoy & Gaimard, 1825).
7.—Spotted Spanish Mackerel . . . . *Cybium queenslandicum* (Munro, 1943).
8.—Mackerel Tuna . . . . *Euthynnus alletteratus* (Rafinesque, 1810).
9.—Yellow-tail Skipjack . . . . *Ferdauia claeszooni* sp. nov.
10.—Skipjack . . . . *Caranx papuensis* Alleyne & Macleay, 1877.
11.—Narrow-barred Spanish Mackerel, *Cybium commerson* (Lacépède, 1800).
12.—Pike . . . . *Sphyraena akerstromi* sp. nov.
13.—Sergeant Fish . . . . *Rachycentron pondicerianum* (Cuv. & Val., 1832).
14.—Broad-barred Spanish Mackerel . . . . . . *Indocybium semifasciatum* (Macleay, 1883).
15.—Whitefish . . . . *Chorinemus lysan* (Bonnaterre, 1788).
16.—St. Peter's Whitefish . . . . *Scomberoides sanctipetri* (Cuv. & Val., 1832).

Hundreds of other fishes were obtained by means of hand-lining, dredging, netting, firearms, explosives, traps, in plankton, stomach-contents of larger fishes, etc., but most of them are outside the scope of this paper.

Family GALEIDAE.

Genus GALEOLAMNA Owen, 1853.

GALEOLAMNA (GALEOLAMNOIDES) ISOBEL, *sp. nov.*

(Fig. 1.)

Diagnosis: A Western Australian Whaler Shark with only about 24 or 25 serrated teeth across either jaw, black tips to some fins, interdorsal ridge developed anteriorly, and details as described and figured below.

Head: As usual in the genus. Predorsal profile not gibbous. Eyes rather large, circular, with nictitating membrane; pupil a vertical slit.

Interorbital convex. Snout gothic arched, blunter than in *Longmania calamaria* (to which it bears a superficial resemblance except that it has less than thirty teeth across jaws). Head 4.55 in total length. Preoral length more than width of mouth. No spiracle. Teeth of both jaws serrated on cusps and shoulders. Dental formula:—

$$\frac{11.1.1.12}{12.12} = \frac{25}{24}.$$

Teeth deflected outwards in each jaw, notched, and serrated almost to tips, those on either side of symphysis smaller than lateral ones. Inner edge of each tooth in upper jaw slightly convex; outer edge deeply notched with coarse serrae on basal shoulder.

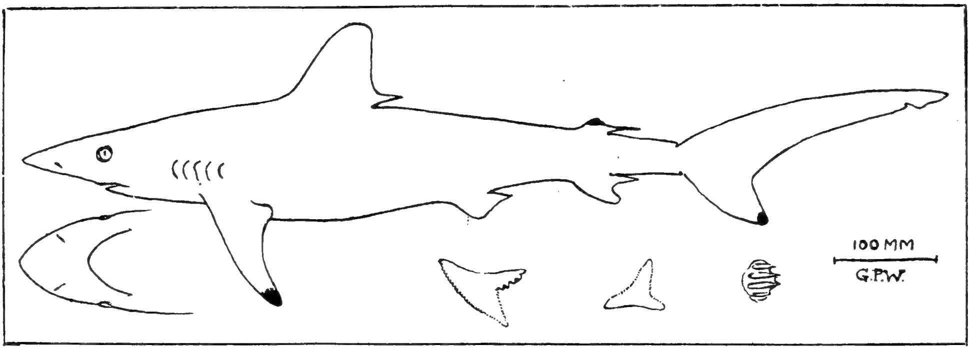

Fig. 1. Whaler Shark, *Galeolamna isobel* Whitley. Type.

Nostrils nearer mouth than to end of snout. Nasal cirrhus small. Labial folds very short. Endolymphatic openings inconspicuous.

Body: Spindle-formed. Lateral line obsolescent. An interdorsal ridge present anteriorly, becoming indistinct before the second dorsal fin. No keel on caudal peduncle which has a lunate pit above and below. Pit organs small and numerous. No umbilical scar. Shagreen of small, close-set, imbricate denticles, each crossed by three (or sometimes four or five) carinae.

Measurements: Following the symbols listed in Proc. Linn. Soc. N.S.W., lxviii., 1943, pp. 114-115, the dimensions in mm. are as follows:—

H.1	158	H.10	(no spiracle)
2	200	11	13
3	76	12	48
4	83	13	67
5	188	14	62
6	412	15	1
7	18	16	2
8	17.5	17	17
9	80	18	17
B.1	650	F.8	65
2	450	9	46
3	280	10	37
4	118	11	32

5	90	12	62
6	30	13	—
7	30	14	130
		15	50
F.1	102	16	250
2	77	17	38
3	30	18	37
4	209	19	26
5	20	20	119
6	22	21	270
7	36	22	96

Additional measurements are: Total length, 910 mm., or about 3 feet overall. Second to fourth gill-slits subequal, 20 mm. Eye to first gill-opening, circa 78. Tip of snout to outer angle of nostril, 40. Inner angle of nostril to mouth, about 37. Middle of vent to end of tail, 478, and thus in posterior half of shark.

Fins as usual in the genus. First dorsal origin nearer pectorals than ventrals. Anal larger than second dorsal, its origin before that of the latter and its end behind that of second dorsal. Pectoral angle reaching below first dorsal origin. Upper caudal lobe longer than head, the lower rounded.

Colour: Grey, with iridescence, above and white below. Iris pale bronze. Second dorsal, lower caudal lobe, and pectoral fins tipped with black.

Described and figured from the holotype, an immature female shark, 910 mm. long and 8 lb. in weight. Austr. Mus., Regd. No. I.B.1493.

The liver weighed 3 oz. Stomach contained a piece of fish (*Euthynnus*) used as bait on the hand-line Vertebrae with Maltese Cross calcification.

Locality: Long Island, between Cape Preston and the Mary Anne Group, Western Australia; 31/10/45.

Apparently most closely allied to *Galeolamna fowleri* Whitley (Austr. Zool., x., 1944, p. 255, Ex mouth Gulf Area), but differs in having larger eye, smaller gill-slits and different teeth (as described above), serrated in both jaws; the black tips to some of the fins are also characteristic.

Family Sphyraenidae.

Genus Sphyraena Bloch & Schneider, 1801.

Sphyraena akerstromi, *sp. nov.*

(Plate xi., fig. 1.)

D.v./i., 9; A.i., 8; P.i., 13; V.i., 5; C.15. L.lat. 76 to hypural + 5 to small scales on middle of tail. L.tr. 9/1/15 at first dorsal, to 10/1/9 between second dorsal and anal, and 5½/1/5 on caudal peduncle. About 20 predorsal scales.

Head (353 mm.) 3.7, greatest depth of body (222) nearly 6 in length to end of shortest middle caudal rays (1320). Eye (45). 3.8 in snout (174). Head wedge-shaped. Eye moderate. Nostrils slit-like. Anterior ends of intermaxillary fissures (Schnauzenfurche of Klunzinger) separated. Upper jaw mainly bordered by intermaxillary. A supplemental bone over the maxillary which reaches below middle of eye, its posterior border rounded. Upper jaw with a single series of conical teeth, nearly all subvertical and with four enlarged compressed canines anteriorly. Lower jaw with a single

series of vertical teeth larger than outer ones of upper jaw. A large symphysial canine. Palatines with about four distant canines in a row anteriorly and a further series behind them. Preopercular margin rounded, entire. Operculum with two flat flexible, weakly serrate spines. Cheek-scales in about thirteen to fifteen rows. A few small scales on the top of head posterior to eye and on the flat interorbital, which has a few ridges at its sides. No gill-rakers. Pseudobranchiae present.

Body with back and belly rather flattened, sides compressed, shoulders and lower sides rounded, giving a very solid appearance. Cycloid scales cover the body and there are many auxiliary scales along the back, but scales do not extend over the fins. They are finely granulated, oval, deeper than long. Lateral line with simple tubes, descending to below first dorsal, thence straight to middle of tail. Seventeen interdorsal scales. Vent small, slightly in advance of anal fin.

First dorsal originating before level of pectoral tip and behind level of origin of ventrals, its first two spines subequal (110 mm.), one-third head, or shorter than postorbital. Interdorsal space (245 mm.) more than twice length of base of second dorsal (111). Second dorsal and anal fins with excavate margins. Anal origin and end behind levels of origin and end of second dorsal. Pectoral subequal to postorbital, its origin midway between dorsal and ventral profiles. Ventrals truncate, much shorter than pectorals, and situated below the middle of the adpressed pectorals. Caudal biconcave, with V-shaped median notch.

Colours in life: Grey to bluish-silver above, with eighteen dark grey oblique cross-bars above the lateral line, becoming indistinct fore and aft. Iris pale bronze to brownish. Fins olivaceous-greyish, the ventrals lightest in tone, the pectorals with most olivaceous tinge. Opercular flap and pectoral axil dark grey. The specimen had a slightly disagreeable odour even when alive.

Dimensions:—

Snout to end of shortest caudal rays, 1,320 mm.
Standard length to hypural joint, 1,210.
Lower jaw projects beyond upper, 20.
Interorbital, 105.
Preorbital, 22.
Postorbital (horizontal from eye), 146.
Maxillary, 196.
Width of head, 134.
Depth of head, 165.
Width of body, 147.
Depth between 2nd dorsal and anal origins, 209.
Depth of caudal peduncle, 94.
Predorsal length, 509.
First dorsal fin: height, 110; base, 125; last spine, —.
Second dorsal fin: height, 135; base, 111; last ray, 65.
First dorsal origin to second dorsal origin, 370.
End of second dorsal to upper caudal ray, 216.
End of second dorsal to end of anal, 145.
Anal fin: height, 135; base, 97; last ray, 61.
End of anal to lowest caudal ray, 225.
Pectoral: length, 144; base, 41.

Snout to ventral origin, 472.
Ventral: length, 92.
Ventral origin to that of anal, 437; to pectoral (obliquely), 130; to origin of first dorsal, 214.
Distance between tail-tips, 250; upper caudal ray about 224.

Liver smooth, with three or four lobes. Pyloric caeca numerous. The stomach contained the bones and fin-rays of a couple of large fish. Swim bladder subcylindrical, with two rounded lobes anteriorly. Immature female, left ovary (365 x 40 mm.) larger than right (330 x 50), pale pink, no ova visible.

Described and figured from an immature female, 1,445 mm., or 4 ft. 10 in. in total length.

Locality: Off Lowendal Island, between Barrow Island and the Monte Bello Group, Western Australia. Caught on trolling line with strip of white fish skin (*Chorinemus*) as lure, September 17, 1945, when the writer was aboard the ketch *Isobel,* under charter to the C.S.I.R. Division of Fisheries.

Affinities: Comes down to the West Indian Barracuda (*Sphyraena picuda*) in Weber and de Beaufort's key (Fish. Indo-Austr. Archip., iv., 1922, p. 218, et seq.), but differs very much in the size of the eye and its ratios to other parts of the head; also the maxillary is more than half the length of the head, the ventrals are much shorter than the pectorals, and the outline of the caudal fin is different. Compare, however, the variation in further specimens mentioned below.

Variation: A second specimen of this Pike was trolled off False Cape Bossut, Western Australia, on September 29, 1945. It agrees in general with the Lowendal Island one, but has the following noteworthy characters:—

D.v./i., 8; L.Lat. 115 to hypural + 5 (extraordinary variation!). Tr. 11/1/22 at first dorsal to 12/1/13 between second dorsal and anal, and 7/1/7 on caudal peduncle. More than 20 predorsal scales.

Head (335 mm.) 3.9, depth (210) 6.3 in length to end of shortest middle caudal rays (1,334). Eye (37) 4.0 in snout (149).

Maxillary reaching below anterior margin of eye. Only two slightly enlarged canines in upper jaw, anteriorly, and one, barely enlarged in lower jaw anteriorly; six to seven large teeth along each palatine. A few spiny rudimentary gill-rakers.

Twenty-six interdorsal scales. First dorsal originating behind level of pectoral tip, and behind level of origin of ventrals, its first two spines (97 mm.) less than one-third head and shorter than postorbital (143). Interdorsal space, 281 mm. Base of second dorsal, 111. Pectoral length, 142. Ventrals inserted slightly behind the level of the middle of the adpressed pectorals, 88 mm. long. Standard length, 1,270. Interorbital, 90. Preorbital, 26. Maxillary, 152. Depth between second dorsal and anal origins, 178; of caudal peduncle, 83; predorsal length, 508. First dorsal origin to second dorsal origin, 383 mm. Total length, 4 ft. 11 in.; weight, 38 lb.

A third and smaller example was trolled about six miles west of Emeriau Point, Western Australia, on October 16, 1945. It was similar to the others, but had a dark grey blotch just below lateral line between second dorsal

and anal fins; also two more such blotches on caudal peduncle, but not quite bilaterally symmetrical.

D.v./i., 9; A.i., 8; P.i., 14. L.lat. 83 to hypural + 6 on tail. L.tr. 12/1/14 to 10/1/9 to 5½/1/5. About 23 predorsal scales.

Head (233 mm.) 3.9, greatest depth of body (136) 6.6 in length to end of shortest middle caudal rays (910). Eye (28) nearly 4 in snout (110). Maxillary (115 mm.) reaches below anterior half of eye, its posterior edge concave. Teeth as in specimens described above, but six or seven along palatines. Opercular spines hidden. No scales on interorbital. Some scales extend between bases of caudal rays. About 19 interdorsal scales.

Second dorsal spine (68 mm.), the longest less than one-third head.
Standard length, 835 mm.
Lower jaw projects, 14.
Interorbital, 65.
Preorbital, 16.
Postorbital, 94.
Maxillary, 115.
Width of head, 79.
Depth of head, 100.
Width of body, 83.
Depth between second dorsal and anal origins, 119.
Depth of caudal peduncle, 58.
Predorsal length, 340.
Interdorsal space, 177.
First dorsal fin: height, 70; base, 82; last spine, 32.
Second dorsal fin: height, 90; base, 74; last ray, 43.
First dorsal origin to second dorsal origin, 255.
End of second dorsal to upper caudal ray, 151.
End of second dorsal to end of anal, 86.
Anal fin: height, 87; base, 72; last ray, 45.
End of anal to lowest caudal ray, 140.
Pectoral: length, 94; base, 28.
Snout to ventral origin, 308.
Ventral length, 64.

Ventral origin to that of anal, 312; to pectoral (obliquely), 89; to origin of first dorsal, 132.

Distance between tail-tips, 195; upper caudal ray about 139; lower, 135.

Stomach contained bitten and digested Rock Cod (*Epinephelus*) swallowed tail first. Testes, 240 x 35 mm.

Described from a male specimen, 835 mm. in standard length, or L.C.F. 910, or total length, 38 inches; weight, 11 lb. Caught on a white feather jig.

A fourth small Pike was caught in the fish-trap on Onslow Beach, Western Australia, on November 3, 1945. It agrees in general facies with the above described specimens, but shows variations in scale-counts and colours and the caudal fin is evenly forked, not biconcave. It had the following characters, noted the day after it was caught:—

D.v./i., 7; A.i., 8; P.i., 13. L.lat. 120 to hypural + 5 to base of middle caudal rays. L.tr. 13/1/19 at first dorsal to 15/1/13 between second dorsal and anal, and 7/1/8 on caudal peduncle. About 29 predorsal scales.

Head, 159 mm. (i.e., 3.7 in length to caudal fork).
Greatest depth, 74 (7.9 in L.C.F.).
L.C.F., 590.
Eye, 21.
Snout, circa 74.
Total length, 26 inches.
Weight, 2 lb. 2 oz.
Standard length, 546.
Lower jaw projects, 10.
Interorbital, 29.
Preorbital (smashed), 13??.
Postorbital (horizontal from eye), 63.
Maxillary, 73.
Width of head, 44.
Depth of head, 55.
Width of body, 47.
Depth between second dorsal and anal origins, 74.
Depth of caudal peduncle, 35.
Predorsal length, 218.
First dorsal fin: height, 50.
First dorsal fin: base, 58.
First dorsal fin: last spine, 18.
Second dorsal: height, 57.
Second dorsal: base, 51.
Second dorsal: last ray, 26.
First dorsal origin to second dorsal origin, 170.
End of second dorsal to upper caudal ray, 109.
End of second dorsal to end of anal, 54.
Anal fin: height, 55.
Anal fin, base, 44.
Anal fin: last ray, 28.
End of anal to lowest caudal ray, 98.
Pectoral: length, 59.
Pectoral: base, 16.
Snout to ventral origin, 210.
Ventral length, 45.
Ventral origin to that of anal, 187.
Ventral origin to pectoral (obliquely), 58.
Ventral origin to origin of first dorsal, 64.
Distance between tail-tips, circa 80.
Upper caudal lobe, 92.
Lower caudal lobe, 80.
Interdorsal space, 108.

General characters as in previous three specimens, but maxillary barely reaches below anterior margin of eye, and is less than half the length of the head. There are about 30 interdorsal scales, the ventrals originate behind the level of the middle of the adpressed pectorals; caudal evenly forked, the upper lobe longer; the body is more slender than in the other, older, specimens.

Stomach contained yellow scum or liquid. Immature male. Testes, 170 x 5 mm.

Head, etc., preserved.

Colour: General colour, the day after death, dull olivaceous above, white below. Nine well-marked dark lateral blotches between pectorals and level of second dorsal and anal fins and about five more indistinct ones posteriorly. Pupil bluish-black; iris silvery white with a golden to olivaceous upper lid. Tips of jaws dusky. Fins yellow, more or less tinged with olivaceous, except the ventrals, which are white.

This species is named after Mr. Eric Akerstrom, of Geraldton, Western Australia, skipper of the ketch *Isobel,* in appreciation of his successful completion of the cruise and with whose name I would join those of the wireless operator and crew, with due acknowledgments for their services during our five months' trip: Sergeant R. J. Berry, R.A.A.F.; Messrs. Arthur Douglas, Thomas Taylor, Leslie Fletcher, Alfred Pulleine, and Alfred Reichard.

AUSTRALUZZA, *gen. nov.*

Orthotype, *Sphyraena novaehollandiae* Gunther, 1860.

Differs from true *Sphyraena* in having origin of ventrals much nearer lower jaw than base of caudal, instead of about midway between the two. From the West Indian barracuda (subgenus *Agrioposphyraena*), the new Australian genus differs in having the first dorsal fin, as well as the ventrals, inserted well behind the level of the tip of the adpressed pectoral. The l.lat. scales are more numerous than in most species of *Sphyraena,* the maxillary ceases well before the eye, and the fish is very slender. The Snook should now be called *Australuzza novaehollandiae.*

Family CARANGIDAE.

Genus FERDAUIA Jordan, Evermann & Tanaka, 1927.

Ferdauia Jordan, Evermann and Tanaka, Proc. Calif. Acad. Sci. (4), xvi., 1927, p. 662. *Ex* Jordan, Evermann and Wakiya, MS. Orthotype, *Carangoides jordani* Nichols, 1922, from the Hawaiian Islands.

FERDAUIA CLAESZOONI, *sp. nov.* (1).

(Plate xi., fig. 2.)

D.vii./i., 28; A.ii./i., 24; P.ii., 19; C.16. Scutes 13. Gill-rakers 7/13. Head (150 mm.) 3.6, depth (160) 3.4 in length to caudal fork (545). Eye, 26 mm.; snout, 60; for other dimensions see tables below.

Head compressed. Lower jaw shorter than upper. Lips rounded. Teeth all villiform, in patches on jaws, vomer and palatines; no outer enlarged teeth. Maxillary not nearly reaching level of eye. Upper profile more convex than lower.

Body compressed, covered with small scales. Breast naked, except for a C-shaped patch of scales extending forwards between pectorals and ventrals almost to gill-opening. Scales also extend on part of pectoral fin and over anterior halves of soft dorsal and anal lobes as thick pads, in addition to the usual basal sheaths. Curved portion of lateral line typically longer than straight portion, their junction below the 14th dorsal ray and over the 7th or 8th anal ray. Scutes commence above posterior end of anal

(1) Named in honour of Skipper Haevik Claeszoon van Hillegom (of the Dutch vessel *Zeewolf* which approached North-western Australia in 1618), who observed seaweeds and birds along the coastline from about 21 deg. to 28 deg. S.lat.

fin, and are deepest on the caudal peduncle. Fins as usual in Carangidae, without any produced spines or rays.

Colours in life, dull green above and on fins, silvery below. Yellow to pale olive caudal fin. Some irregular spots of bronze to grey on flanks and

	Specimen No. 9. Holotype.	Specimen No. 4.	Specimen No. 10.	Specimen No. 18.
L.C.F.	545 mm.	750	670	514
Weight	5½ lb.	10	10	4
Total Length	24½ in.	33	-30	
Head	150 mm.	195	185	146
Depth	160	195	168	158
Eye	26	27	24	25
Interorbital	41	55	61	
Postorbital	60	89	80	
Preorbital	48	40	28 to 50	
Snout	60	-80	70	
Maxillary	60	74	70	
Predorsal Length .	197			
Gill-rakers	7/13.	6/16	6/20	6/16
Scales on curved part of l.lat. . ..	c.67			
Scutes	13	16	18	13
Length of straight portion of l.lat. .	177	255	230	
Length of curved portion of l.lat. .	213	255	240	
Depth of Scutes ..	9	14	13	
Depth between first Dorsal and Ventrals origins	154	195	168	
Base of Second Dorsal	200	275	240	
Dorsal	vii./i., 28	vii./i., 28	vii./i., 30	vii./i., 29
Anal	ii./i., 24	ii./i., 24	i/i., 27	ii./i., 23
Pectoral	ii., 19			
Caudal	16			
Length of Pectoral.	193 mm.	237	215	
Length of soft Dorsal Lobe	87	95	69	
Length of Anal Lobe	77	95	75	
Length to middle of Caudal Peduncle.	482	675	600	
Depth of Caudal Peduncle	18		18	
Locality	S.W. of Cape Baskerville, W.A.	Off Whaling Station, near Point Cloates.	16 m. N. of Cape Preston = variety *prestonensis*, nov.	Whaling Station, Point Cloates.

a couple of large dark blotches on straight part of lateral line. Pupil blue, iris bronze.

Described and figured from the holotype of the species, a male 545 mm. in length to middle caudal rays, or 24½ inches overall and 5½ lb. in weight.

Type locality: South-west of Cape Baskerville, Western Australia.

Dimensions and formulae of the holotype and three other specimens are as in the foregoing table. Their stomachs contained various small fishes, often too digested for determination, apart from a mackerel (*Rastrelliger*) and a Leatherjacket, also a scallop and crustaceans; amongst the latter Mr. Keith Sheard noted "Pagurid *Glaucothoe* and Squillid larvae *Alima*."

Variation: Nine specimens (Nos. 1 to 8 and 18), 45 to 82 cm. long, trolled from the Point Cloates to North-west Cape area, showed no important variation from the holotype, but an elongate variety of this species was encountered 16 miles north of Cape Preston, Western Australia, which had the characters tabulated above, depth 3.9 in L.C.F., and coloration as follows.

Colours: In life, very pale greyish-blue to faint greenish above, becoming white on the sides and below. Sides of body with a few scattered round grey spots, smaller than pupil; no large blotches. Pupil black, iris bronze to pale grey. Fins pale olive-grey, not yellow; the anal and caudal with very narrow milky-white margins. Inner pectoral axil dark grey. A dark grey blotch on second dorsal and anal lobes became more pronounced after death. Flesh dark red.

This may be known as var. *prestonensis*, nov.

Comparison with allied species: The new species and variety can be immediately distinguished from congeners by the size and position of the eye, depth of preorbital, numbers of fin-rays, small number of scutes not extending far forward, convex profile, form and proportions as described above. The genus *Ferdauia* accommodates several species of Trevallies which have mostly been grouped by authors into a species known as *Caranx* or *Carangoides ferdau* (Forskal). Actually, Forskal's work (Descr. Animalium, 1775, p. 55) is not binomial, his "*Scomber ferdau*" from Djedda, Red Sea, having first been latinized by Bonnaterre (Tabl. Encycl. Meth. Ichth., 1788, p. 141). The Red Sea type differs from mine in having transverse bars on the body. The Trevallies which appear to be referable to *Ferdauia* are *bajad* (Ruppell, 1831); *evermanni* (Nichols, 1921); *ferdau* (Bonnaterre, 1788); *fulvoguttatus* (Ruppell, 1831); *hemigymnostethus* (Bleeker, 1851); *jordani* (Nichols, 1922); *laticaudis* (Alleyne & Macleay, 1877); and *venator* (Playfair, 1868), from the Red Sea, Hawaiian Islands, East Indies, New Guinea and Seychelles, besides my new Western Australian forms. The following may be allied but not congeneric: *Carangoides aureoguttatus* Bleeker, 1853; *Caranx gilberti* Jordan & Seale, 1906; and *Caranx novaeguineae* Cuvier & Valenciennes, 1833.

Genus CARANX Lacepede, 1802.

CARANX PAPUENSIS Alleyne & Macleay, 1877.

(Plate xi., fig. 3.)

Caranx papuensis Alleyne & Macleay, Proc. Linn. Soc. N.S. Wales, i., 1877, p. 325, pl. x., fig. 3. Hall Sound, New Guinea. *Id.*, McCulloch, Mem. Qld. Mus., viii., 1924, pp. 67 and 69, pl. xiii.

Isobel specimens of this species, which is new to the fish-fauna of Western Australia, had the following characters:—

Lips rounded, coriaceous; jaws subequal or lower jaw the longer. A row of strong canines, enlarged anteriorly, and outside a band of cardiform teeth in each jaw. Patches of villiform teeth on the vomer and palatines. Maxillary reaches to below middle or nearly to posterior margin of eye. Upper profile much more convex than lower. Gill-rakers spinulose superiorly; about three to five rudiments, plus 2 or 3/10 to 14 on first branchial arch.

Body and fins as usual in Carangidae. A naked patch between bases of ventrals and isthmus; body-scales encroaching well in advance of a line joining pectoral and ventral bases. A patch of vestigial median scales before ventrals in specimen 1; naked in others. Straight portion of lateral line longer than curved, the junction of the two below 7th to 9th dorsal and over 1st to 3rd anal ray. Depth of scutes greatest at or just before caudal peduncle. Scutes very strong and sharp, those of one fish cutting right through one of my toe-nails as the fish flapped about on deck. Scutes extend all along straight part of l.lat. No produced spines or rays.

D.vii. to viii./i., 19 to 21; A.ii./i., 15 to 17.

Dimensions (in mm. unless otherwise stated) and other numerical characters.

Specimen	1	2	3	4	5	6	7	8	9	10	11
L.C.F. in mm.	660	777	613	450	760	725	620	715	850	710	710
Weight in lb.	14	18	10	4½	19	16	11	16	24	15½	14½
Total length in in.	30	33	27½					32			
Head in mm.	190	206	167					203	222		
Depth	212	245	204					245	235		
Eye	27	30	27					26	38		
Interorbital	59	62	50					61.5			
Postorbital	104	111	92					102			
Preorbital	47	46	39					51			
Snout	60	65	53					66			
Maxillary	88	96	80					96			
Scales on curved part of lateral line		54	55					55			
Scutes	27	29	32					32	29	35	29
L.lat. straight part (mm.)	260	290	239					292			
L.lat. curved part	218	246	193					240			
Depth of scutes	30	28	22					29			
Depth between first dorsal and ventral origins	214	237	200					230			
Base of second dorsal fin	230	262	200					255			
Length of pectoral	209	246	208					236			
Dorsal lobe	117	123	115					132			
Anal lobe	110	124	108					118			
Length to middle of caudal peduncle	590	660	540					610			
Depth of caudal peduncle	—	22	20					23			
Sex	m.	f.	m.	m.	m.	m.	f.	f.	f.	f.	f.

Life colours: Dull pale greenish above and on fins, though these are smoky grey distally and the caudal is slate-grey. Pupil dark blue; iris dark brown. Pectoral axil dark grey. Lower parts silvery. (Specimens 1 to 7, etc.)

In specimen 8, the sides of the body had numerous dark grey flecks of different sizes, but all much smaller than pupil, smallest and densest about curved portion of lateral line and changing their number and shape. Otherwise ground-coloration normal.

In specimen 9, the posterior margins and tips of second dorsal and upper caudal lobes were mustard yellow.

Stomach contents were usually too digested for identification but were mostly fishes up to about 7 inches long, but one had fed on crabs. Specimens were immature at 620 mm. and even the largest ones were not fully developed.

Eleven examples were caught by trolling at these localities: (1) off Frazer Island, Point Cloates, September 8, 1945; (2 to 5) off North-west Cape, September 10 to 11; (6 and 7) Monte Bello Islands, September 18; (8) off Cape Bertholet, October 8; (9) about 23 miles south-west of Broome, October 21; and (10 and 11) 16 miles north of Cape Preston, October 31. These ranged from 45 to 85 cm. in L.C.F. and weighed from 4½ to 24 lb.

Mr. F. J. Rankin gave me another example from Onslow.

Mr. M. MacBolt sent me a drawing of another, 51½ inches in total length and weighing 62 lb., gutted, which he caught at Ningaloo, Point Cloates, on November 19, 1944. Three days earlier he had obtained one there 29 inches long with weight 15 lb. The gut of the larger one contained an octopus, the longest tentacle of which was 18 inches.

Genus SCOMBEROIDES Lacépède, 1802.

SCOMBEROIDES SANCTIPETRI (Cuv. & Val., 1832).

On October 16, 1945, in Hadley Passage, King Sound, W.A., a Whitefish new to the Western Australian fauna, was caught, although I had earlier seen photographs and specimens from other parts of the coastline. The King Sound specimen was 865 mm. long (L.C.F.) or 29 inches overall and weighed 5½ lb. Maxillary (61 mm.) reaching below posterior part of eye. D.vi./i., 20; A.ii./i., 18. Head, 121 mm.; eye, 18; depth, 150. Gill-rakers, 7/16. Scales lanceolate.

Life colours: Grey above, silvery on sides, white below; five U to V-shaped grey marks (traditionally the finger-prints of St. Peter) below the lateral line anteriorly; four diffuse dusky blotches above the lateral line correspond to the posterior four "finger-prints"; a butter-yellow tinge along abdomen. Pupil black, surrounded by a smoky-coloured area; rest of iris whitish. A large black blotch covers distal half of second dorsal lobe. Pectorals greyish to dull yellow, with greenish-grey axil. Ventrals bright yellow with slight grey median marks and broad white margins. Anal white with slight blackish blotch on centre of lobe and some yellow anteriorly. Dorsal finlets grey; anal finlets white. Caudal pearly grey, median rays dirty whitish.

The fish was fat and in good condition; female with roes bright yellow, 260 by 45 mm., separated by the forwardly situated anal interhaemals to either side of which the coelome extended posteriorly so that the gonads reached back to over the seventh anal ray.

Family SCIAENIDAE.
Genus SCIAENA Linné, 1758.
SCIAENA ANTARCTICA REX Whitley, 1945.
(Fig. 2.)

Sciaena antarctica rex Whitley, Austr. Zool., xi., June 11, 1945, p. 26. Onslow, Western Australia.

This subspecies has not hitherto been figured, so I give here a description and illustration of a 3½ foot female which I caught at North Turtle Island, off Port Hedland, W.A., in September, 1945.

D.x., i., 23; A.ii., 7; P.ii., 17; V.i., 5; C.14.

L.lat. 48 to hypural + 6 along tail. Tr. 9/1/20.

Head (265 mm.) 3.5, depth (242) 3.4 in standard length (930). Eye (38) 7 in head. Preorbital, 28 mm.; interorbital, 60; maxilla, 99, its end 38 deep; snout, 60; postorbital, 169; predorsal length, 308; first dorsal base, about 200; second dorsal base, 344; longest (fourth) dorsal spine, 144; anal base, 88; second anal spine, 75; pectoral length, 148 (fifth ray longest); pectoral base, 36; length of ventral fin, 137; middle caudal ray, 119; depth of caudal peduncle, 75 mm.

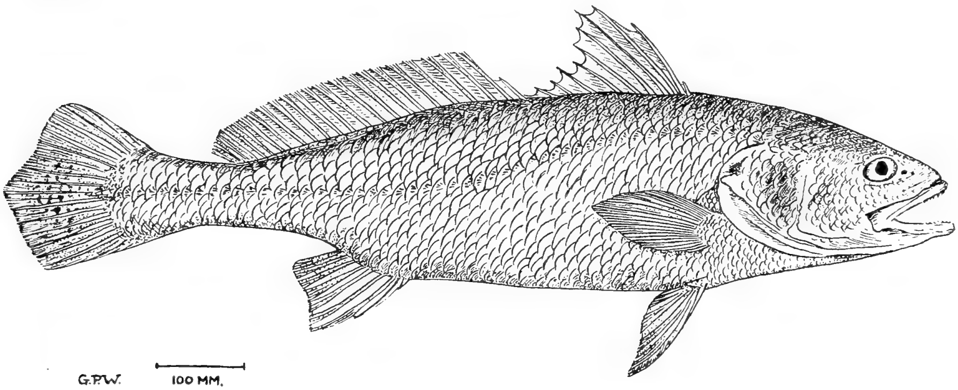

Fig. 2. Mulloway, *Sciaena antarctica rex* Whitley. A specimen from Turtle Island, off Port Hedland, Western Australia.

Maxillary extending to below posterior margin of eye, partly sheathed by preorbital. Lips coriaceous. An outer uniserial row of short canines, largest anteriorly, in upper jaw, behind these a strip of villiform teeth; one to three rows of small canines along lower jaw. Vomer and palatines toothless.

Gill-rakers, 4-6. Preopercular margin with some spaced points. No noteworthy pores on head.

General facies as in *Sciaena antarctica* and as figured here. Second anal spine slender, not strong. Articulations of the fin-rays small and numerous.

General colour bronze, with some yellow below head and coppery on operculum. Unpaired fins dark reddish brown with a few indistinct dark spots on middle of tail. Pectorals dark yellowish. Ventrals dark yellowish

anteriorly but becoming light grey posteriorly. Eye bronze. Inside of mouth yellow. The dark coloration suggests a muddy habitat.

Vertebrae 14, to over anal origin, plus 9 = 23. Stomach was empty. Each roe was about 250 by 28 mm. and there appeared to be two small auxiliary roes besides the main ones. Some tapeworms in the flesh.

Described and figured from a female specimen, 1,075 mm. or almost 3½ feet long and 27½ lb. in weight.

Locality: Three miles offshore, North Turtle Island, off Port Hedland, Western Australia; hooked on mullet (*Moolgarda pura*) bait, September 27, 1945.

A second specimen, one of eight caught off the jetty at Onslow on November 4, 1945, was a male, 3 ft. 1 in. (940 mm.) in total length; weight 17 lb. whole. Standard length, 820 mm. Head, 233; depth, 215; eye, 32; maxillary, 91, reaching below posterior half of eye; pectoral length, 130. Anal margin truncate.

Br.7; D.x., i., 23; A.ii., 7; P.ii., 17; L.lat. 50 to hypural + 5 to base of middle caudal rays. Small median scales to end of tail. L.tr. 13/1/18.

Gill-rakers, 6-7. Stomach empty. General characters as in Turtle Island example.

Family Scolopsidae.

Scaevius, *gen. nov.*

Orthotype, *Scaevius nicanor*, sp. nov.

This new genus differs from most of the many genera or subgenera which have been variously grouped around *Nemipterus* or *Synagris*, *Pentapodus*, *Dentex*, etc., by authors, notably in having no canine teeth, the dentition consisting of bands of fine teeth on jaws and none on palate. There is no strong suborbital spine as in *Scolopsis* and its subgenera. Other striking features are the rather numerous cheek-scales; naked preopercular flange, suborbital and interorbital; ovate body-form, dorsal margin not deeply notched, and moderate sized eyes. Other characters as described for the species.

Scaevius nicanor, *sp. nov.*

Upper profile gently convex, the lower much less convex. Lips fleshy, maxillary not reaching below eye, partly sheathed by preorbital, but without a toothed ridge as in *Gnathodentex*. Mouth not very protractile, though premaxillary pedicels are longer than eye. No symphysial knob. Bands of fine, small teeth on jaws. Apparently none on vomer or palatine ridges. No canines, incisors or molars. Velum maxillare present. Tongue acutely rounded. Preorbital broad and deep, naked, entire anteriorly but denticulated posteriorly and ending in three small spines below eye, none of them distinct as in *Scolopsis*. Preoperculum entire, evenly rounded, spineless, its flange naked. Chin and the weakly convex interorbital scaleless. Nostrils small, approximate, the anterior with raised rims. About six rows of cheek-scales. Opercula scaly, entire. A small opercular spine almost covered by scales. Vertex scaly. Eyes moderate with free, entire margin, and a subocular shelf. Five branchiostegals. No barbels or noteworthy pores on chin. Gill-membranes united before isthmus. About 6 or 7 stumpy gill-rakers on lower part of first branchial arch.

Head (59 mm.) 2.8, depth (56.5) 2.9 in standard length (165). Eye (13.5) 4.3, interorbital (17) 3.4, snout (20) 2.9 in head.

Preorbital, 13 mm. Predorsal length, 63. Depth of caudal peduncle, 20.5. Longest (third) dorsal spine, 24.5. Pectoral length, 39. Ventrals, 39. Third anal spine, 15.5. Upper caudal lobe, 43. Total length, 8 inches.

Body elongate-ovate, rather robust anteriorly, and somewhat compressed posteriorly, covered with fairly large, imbricate, ciliated and pitted scales, fairly uniform in size, and which do not form sheaths for the fins, although some encroach upon the pectoral and caudal fins and there is a small pointed axillary scale to each ventral fin. Cleithrum not exposed. Lateral line continuous, running parallel to and near the dorsal profile. Each central lateral line-scale tube divides into two which pierce the scale-border to form two notches. L.lat. 42. L.tr. 3½/1/16 between origins of dorsal and anal, to 3/1/4 across caudal peduncle. Between the lateral line and the dorsal fin are 2½ to 3½ scales. Vent slightly in advance of anal fin.

Dorsal fins connected, not notched, and with membranes not deeply incised, the first dorsal fin composed of slender, homocanth, rather weak spines, none produced or notably lengthened, the second dorsal fin consists of branched rays with few articulations, the last not lengthened. D.x., 9; A.iii., 7; P.16; V.i., 5; C.15 branched rays.

Three anal spines, increasing in length backwards, continuous with the soft fin. Pectoral rays longest above, mostly branched; no simple finger-like rays. Ventrals pointed, reaching anal origin. Caudal slightly forked, upper lobe longer, neither lobe produced into filaments.

Colours in life: Dark olive on top of head, paler along back. Eye orange with blue and milky bars through it. Bright blue bar across interorbital, two broader blue bars across top of snout, two narrower blue bars obliquely forward on preorbital, other paler blue marks on the brown ground colour of the upper lip. A blue fleck over margin of interoperculum and orange to blue tinges along lower limb of preoperculum. Three radiating blue bars backwards from eye (1) across postorbital, (2) over operculum and continued to tail, and (3) to base of pectoral. A paler blue stripe over eye and along back to below soft dorsal. Spaces between blue bars brownish, scales with dark grey edges. Belly white. Lateral line greyish. A conspicuous black ocellus, encircled by blue, on upper scales before caudal root.

Dorsal yellow to pale pink with submedian row of milky marks and some similar inframarginal smaller milky marks posteriorly. Anal yellow proximally and pink distally with a few oblique rows of milky spots. Pectoral yellow to pink, with grey base. Ventrals and caudal pale pink, the median membrane of the caudal blue.

Described from the holotype, eight inches in total length. Austr. Mus. Regd. No. IB.1496.

Locality: Gregory, Cape Peron, Shark's Bay, Western Australia; August 30, 1945. Coll. G. Whitley.

Two paratypes, about 5½ inches long, were received by the Australian Museum from Darwin from Messrs. Christie and Godfrey in 1903 (Regd. Nos. I.6056 and 6057). The late W. E. J. Paradice collected two more, 6½ to 6¾ inches long at the Sir Edward Pellew Islands, Gulf of Carpentaria,

in 1923. (Regd. Nos. IA.1471 and 1650): "Caught on sand flat by net." This new species therefore ranges from Western Australia to the Northern Territory. Suggested vernacular name, Jurgen.

LUNICAUDA, *gen. nov.*

Orthotype, *Mesoprion*?? *emeryii* Richardson (Icones Piscium, 1843, p. 7, pl. iii., fig. 2, from Barrow Island, North-west Australia) = *Lunicauda emeryii*. New synonym: *Heterognathodon nemurus* Bleeker, 1852.

The species upon which this new genus is based was originally described by Richardson from a drawing made by Lieut. James B. Emery, of H.M.S. *Beagle,* in either January, 1838, or 1840. (2) No specimen of *emeryii* was known to exist in any Museum. Over a century after Emery, I was with the ketch *Isobel* off Thevenard Island, North-western Australia, when one of the air-crew, Corporal L. G. Matthews, caught by hand-line on garfish bait a fine specimen of this long neglected and beautiful fish.

Later we obtained a couple more in the Monte Bello Islands.

Richardson placed this species in the genus *Mesoprion* with two question marks. *Mesoprion* Cuvier & Valenciennes (Hist. Nat. Poiss., ii., 1828, p. 441) was proposed for a group of fishes with an indentation in the form of a saw on the middle of the side of the head, with teeth on vomer and palatines, long and pointed pectorals, etc. The logotype is *M. lutjanus* (Bloch) and *Mesoprion* is a synonym of *Lutjanus.*

Mesoprion?? *emeryii* can now be demonstrated to have the pre-operculum entire, not notched, no palatine dentition, pectorals short, etc., and actually should be removed from the Lutjanidae and transferred to the Scolopsidae.

Generic description: Habit fusiform. Head conic. Mouth barely reaching eye, moderately protractile. Maxillary smooth, sheathed by pre-orbital. No symphysial knob. No barbels. Broad bands of movable villiform teeth in jaws; no incisors or molars. Two small suberect canines on each side of the coriaceous symphysis of the upper jaw and one forwardly-directed exterior canine on each side of lower jaw. Vomer and palatines without teeth. Velum maxillare present. A rudimentary tongue, far back. Preorbital not deep, naked, entire, ending in an acute point below eye, not a definite spine as in *Scolopsis*; its border is entire and its surface has minute spaced pores. Preoperculum with small serrae along upper edge, but entire around its angle, and with its flange scaly. Chin and snout naked. The broadly convex interorbital and rest of head scaly. Nostrils small, approximate, the anterior with well-raised rims. Five or six rows of cheek-scales (excluding preopercular flange). A small opercular spine. Eyes rather large, with free entire margin and a subocular shelf. Six branchiostegals. Gill-membranes united before isthmus. About five stumpy gill-rakers on lower part of first branchial arch.

Body covered with moderate-sized, imbricate, adherent ctenoid scales

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(2) More likely in 1838, as J. J. Fletcher (Proc. Linn. Soc. N.S. Wales, 1920 (1921), pp. 614-615) remarks that Emery was adding to his collection of coloured drawings of Australian fishes in September, 1839, and Richardson (Icones Piscium) had only twelve paintings, in the complete portfolio.

which do not form sheaths for the fins and only encroaching on the caudal. Small axillary scale at ventral fin. Cleithrum not exposed. Lateral line continuous, near and parallel to dorsal profile. Lateral line scales with simple tubes or pores. L.lat. 55. L.tr. about 3/1/20 to 2½/1/5½ across caudal peduncle. Vent slightly ahead of anal fin.

Dorsal fins connected, not notched and with membranes not deeply incised. Ten to eleven rather weak spines and nine branched rays, none produced. Anal with three short spines, increasing in length backwards, and eight rays. Pectorals short, with upper rays longest. Ventrals pointed, not reaching vent. Caudal emarginate, its upper and lower lobes remarkably produced into tape-like filaments.

The life-colours were: Golden yellow on sides above and milky to whitish below; top of back vivid blue, bounded below by a yellow band entirely above the lateral line. Another yellow band from eye to upper part of caudal peduncle is bordered above and below by a tan band. A milky-white band along lower part of side. Eye bright yellow. Dorsal fins yellow with pale blue spots. Anal hyaline yellow. Pectorals and ventrals hyaline to milky. Caudal vivid purplish-blue, produced above and below into a filament of the same colour. No dark bar across pectoral base.

I had aboard the *Isobel* a water colour copy of Richardson's plate in hopes of rediscovering this species and the live fish agreed very well indeed with this.

Length to caudal fork about 9 inches. Total length, including filaments, 13½ or 14 inches.

Generic diagnosis based on the neotype (Austr. Mus. Regd. No. IB.1549) from off Thevenard Island (in the Onslow region) and two other examples (IB.1550 and 1557) from off Hermite Island, Monte Bellos, Western Australia; September 17, 1945. *Isobel* Expedition.

I find that *Heterognathodon nemurus* Bleeker, 1852, is a synonym of *Lunicauda emeryii,* two Philippine specimens having been examined.

Affinities: Nothing quite like this fish appears to have been generically named in ichthyological literature. Its affinities are evidently with *Pentapodus.*

The external forwardly-directed lower canines, l.lat. more than 50, prolonged caudal lobes, lack of dark bar on pectoral and coloration generally, separate my new genus from the genotypes of *Pentapodus* (*vitta*) and *Heterognathodon* (*bifasciatus* = *caninus*).

The synonymy is as follows:—

LUNICAUDA EMERYII (Richardson).

Mesoprion emeryii Richardson, Icones Piscium, 1843, p. 7, pl. iii., fig. 2. Barrow Island, North-western Australia. *Id.* Richardson, Rept. 12th meet. B.A.A.S., 1842 (1843), p. 17. *Id.* Whitley, Rec. Austr. Mus., xix., 1934, p. 157.

Heterognathodon nemurus Bleeker, Nat. Tijdschr. Ned. Ind., iii., 1852, p. 754. Celebes.

Pentapus nemurus Bleeker, Atlas Ichth., viii., 1872, pl. 294, fig. 3; vii., 1876, p. 102, and of authors generally.

Lutjanus emeryii McCulloch, Austr. Mus. Mem., v., 1929, p. 208.

Family SARDIDAE.
Genus SARDA Cuvier, 1829.
SARDA ORIENTALIS SERVENTYI Whitley.
(Plate xi., fig. 4.)

Pelamys orientalis Temminck & Schlegel, Fauna Japonica, Poissons, 1844, p. 99, pl. lii. Nagasaki, Japan.

Sarda orientalis serventyi Whitley, Austr. Zool., xi., 1945, p. 41. Albany, Western Australia.

The holotype of the subspecies (W.A. Mus., No. P.3512), 265 mm. long to end of middle caudal rays, is now figured.

Family NEOODACIDAE.
HALETTA, *gen. nov.*

Orthotype, *Odax semifasciatus* Cuvier & Valenciennes (Hist. Nat. Poiss., xiv., "1839" = January, 1840, p. 299, pl. 407) = *Haletta semifasciata.*

Differs from other members of the family in having more than 50 (usually about 55 to 63) transverse rows of scales, instead of from about 30 to 45, as in *Neoodax* spp. The preoperculum is entire, the caudal fin rounded, and the general appearance of the monotypic species is as figured by Cuvier & Valenciennes, Richardson, Roughley, and others. Named after Mr. H. M. Hale, Director of the Museum, Adelaide.

Genus NEOODAX Castelnau, 1875.
SHEARDICHTHYS, *subgen. nov.*

Orthotype, *Malacanthus radiatus* Quoy & Gaimard (Voy. Astrolabe, Zool., iii., 1835, p. 717, pl. xix., fig. 2) = *Neoodax* (*Sheardichthys*) *radiatus.*

Distinguished from typical *Neoodax* by its acutely pointed middle caudal rays, the rest of the fin rhombic rather than rounded, whilst the preoperculum has an entire edge. About 40 to 45 transverse rows of scales.

Named in honour of Mr. Keith Sheard.

Family ELEOTRIDAE.
Genus CARASSIOPS Ogilby, 1897.
CARASSIOPS COMPRESSUS (Krefft, 1864).

Two specimens, from a well 63 feet deep, east of Carnarvon, W.A., obtained in January, 1946, by Mr. H. J. Murray, agree with McCulloch's account of this species (Rec. Austr. Mus., xii., 1919, p. 285) and are referable to the geographic form named *reticulatus* by Klunzinger from Port Darwin.

Not only do these fish constitute a new record for Western Australia, but they indicate the probable line of descent of the interesting Western Australian blind gudgeon, *Milyeringa,* of which I wrote (Austr. Zool., xi., 1945, p. 35), "perhaps evolved from some gudgeon similar to *Carassiops,* which is not known from Western Australia."

Family ALEUTERIDAE.
TANTALISOR, *gen. nov.*

Orthotype, *T. pauciradiatus,* sp. nov.

A Leatherjacket with concave profile, with the dorsal spine originating

over posterior half of eye; pelvis spine rigid, not movable; less than thirty dorsal or anal rays; dermal denticles granulated, rather toadstool-shaped with a peaked apex; and no caudal bristles or spines. This combination of characters separates it from all other genera.

TANTALISOR PAUCIRADIATUS, *sp. nov.*

D.ii./28; A.28; P.11; C.12 (10 branched rays).

Profile of snout concave, making angle of about 145 deg. with the horizontal interdorsal space. Greatest depth (53 mm.) nearly 1.9, dorsal-anal origins (41) 2.4, head (31) 3.2 in length without caudal (101). Eye (11.5) 2.1 in snout (25). Distance from base of dorsal spine to nearest point on orbit (7 mm.) 1.6 in eye. Gill-opening below eye. Distance between orbit and upper end of gill-opening (6) less than depth of latter (7). First dorsal spine strong (25), situated over posterior half of eye, not compressed, with four rows of barbs, the anterior pair having small adpressed barbs with the points barely free; the posterior two rows have a dozen downward and backwardly directed spines, largest above middle of spine and connected by membranes. Second dorsal spine slender, 6 mm. Interdorsal space less than head. No groove along back. Soft dorsal fin slightly elevated at its anterior quarter, with 28 rays, its base (32 mm.) subequal to head. Anal fin oblong, with 28 rays, its base, 30 mm. Eleven simple pectoral rays. Pelvic spine large, tuberculate, rigid, reaching not far from vent. Belly not greatly distensible. Ventral flap spongy, not exceeding spine. Scales with a rather toadstool-shaped granular spinule with peaked apex rising on a pedicle from a radially striated scale-base with polygonal outline. On sides of back the spinules or denticles form groups of 3 to 7. Lateral line indiscernible. No dermal filaments and no bristles or antrorse spines on the caudal peduncle which is longer (14 mm.) than deep (11). Caudal rounded, middle ray (25 mm.) shorter than head. No produced fin-rays.

Life colours: In general, dull green with many small dark-green spots on sides of back; a darker-toned blotch behind gill-slit. Some dark green oblique lines on sides of head reaching to below pectoral fin. Pupil blue, iris yellow. Three dusky bars cross chin. Vivid blue to milky spots along belly. Pectoral green. Second dorsal and anal fins orange. Tail olivaceous with a blackish ocellus above and below near posterior ends of rays. After eight months' preservation, the colours have altered to mostly dull olive of various tones. Several rows of black dots along upper sides. First dorsal membrane edged dark smoky. Caudal dull olive with dark grey, round spot above and below. Other fins dull yellowish. Eye blue. Teeth greenish yellow with brown tips.

Described from the unique holotype, a specimen 126 mm. or 5 inches long. Austr. Mus. Regd. No. IB.1641.

Locality: Cape Peron, Shark's Bay, Western Australia; 31/8/45. Coll. G. P. Whitley and presented by C.S.I.R. Division of Fisheries.

Family LAGOCEPHALIDAE.

CONTUSUS, *gen. nov.*

Orthotype, *Tetrodon richei* Fréminville, Nouv. Bull. Sci. Soc. Philom., iii., April, 1813, p. 250, pl. iv., fig. 2 = *Contusus richei*.

This common southern Australian toadfish, originally described from "Nuytsland," i.e., South Australia, I have collected in South-western Australia. It is also known from Victoria, Tasmania, southern N.S.W. and N.Z., but records of it from the Northern Territory, East Indies and Japan are either referable to other species or caused through uncertainty as to the type locality Bleeker (Verh. K. Akad. Wetensch. Amsterdam, ii., 1855, p. 24, figs. 3, 3a) figured a Hobart example and included the species in his Atlas Ichthylogique des Indes Orientales Neerlandaises (1865).

From Fraser-Brunner's review (Ann. Mag. Nat. Hist. (11), x., 1943, p. 11) it is evident that Fréminville's species is near, or in, the genus *Amblyrhynchotus* Troschel (Arch. Naturg., xxii., 2, 1856, p. 88, ex Bibron MS. in Dumeril, Rev. Mag. Zool. (2) vii., 1855, p. 274) but that name is preoccupied by *Amblyrhynchotus* Tilesius, 1818, a genus of Crustacea. I therefore propose the name *Contusus,* with *richei* as type, and to replace *Amblyrhynchotus* for the other species, if all be congeneric; the distinguishing characters are given in Fraser-Brunner's key.

New Records of Fishes from Western Australia.

Since the appearance of my last list in part two of this paper (this volume, p. 40), I have identified the following species new to the Westralian list. Some of the following were dredged years ago by Mr. A. A. Livingstone, the Onslow ones came from Mr. F. J. Rankin, Messrs. Jenkins and Buller obtained data from the Ord River, and others were collected by myself or identified from specimens in museums.

Nebrodes concolor ogilbyi Whitley. Lacepede Islands and Onslow.
Atelomycterus macleayi Whitley. Egg-case from Turtle Island.
Protozygaena longmani (Ogilby). Derby.
Flakeus megalops (Macleay). Bunbury.
Pastinachus sephen ater (Macleay). Port Hedland, Dolphin Island, and Monkeymia, Shark's Bay.
Taeniura lymnia halgani (Lesson). Airlie Island and Monte Bellos.
Escualosa melanura (Cuv. & Val.). Onslow and Port Hedland.
Plotosus flavolineatus Whitley. Broome.
Thaerodontis favagineus (Bloch & Schneider). Gantheaume Point.
Macroramphosus elevatus Waite. South-western Australia to west of False Entrance, Shark's Bay.
Hippichthys gazella, sp. nov., Broome. Rings 16 + 38, snout half head, dorsal origin slightly behind level of vent, on 6 tail-rings, otherwise near *H. poecilolaemus* (Peters, 1869).
Choeroichthys brachysoma serialis (Gunther). North-western Australia.
Hippohystrix spinosissimus (Weber). Broome and Cape Bossut.
Ardeapiscis welsbyi (Ogilby). Port Hedland and Fremantle.
Cyttus mccullochi, sp. nov. D.ix., 35; A.ii./37; P.i., 16; V.i., 6. L.lat. c. 100. Pectorals and ventrals shorter than eye. Anterior profile evenly convex. Depth of body much less than length without caudal peduncle. Ventral profile moderately convex. Length, 10½ inches. Great Australian Bight, 190-320 fathoms. Formulae and shape (cf. fig. 3) diagnostic.
Pseudorhombus dupliciocellatus Regan. Between Cape Jaubert and Wallal.
Aesopia heterorhinos (Bleeker). Western Australia.
Achlyopa nigra (Macleay). Onslow.
Polyprionum (Hectoria) oxygeneios (Bloch & Schneider). Great Australian Bight, 100 to 120 fathoms, March, 1912.

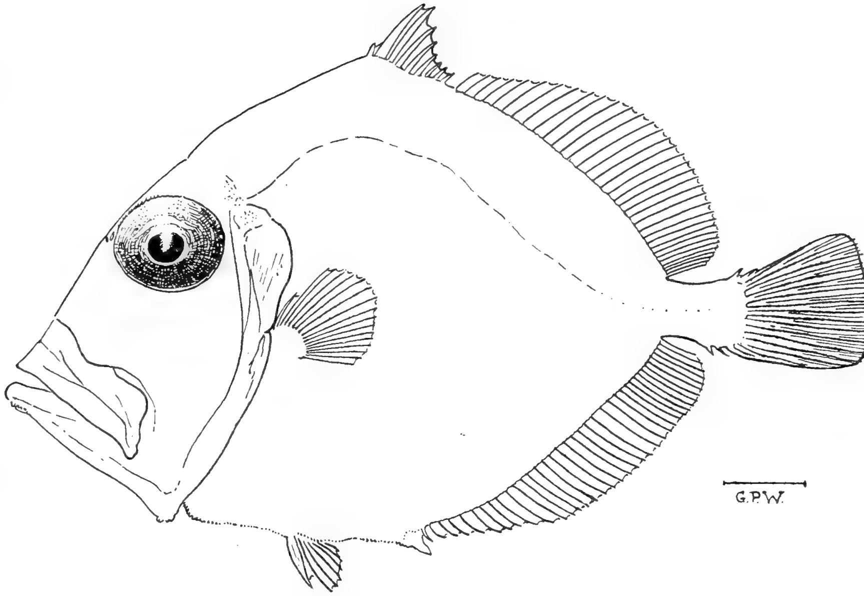

Fig. 3.—McCulloch's Dory, *Cyttus mccullochi* Whitley. Type.

Epinephelus megachir alatus Alleyne & Macleay, 1877. Port Hedland.
Pristiapogon brevicaudatus (Weber). Dredged between Broome and Cape Bossut.
Hemiramphus quoyi Cuv. & Val. Dampier Archipelago and Exmouth Gulf.
Chromileptes altivelis (Cuv. & Val.). Gantheaume Point.
Leptochromis tapeinosoma wilsoni Whitley. Cape Leveque.
Fowleria aurita (Cuv. & Val.). Cape Leveque.
Scomberoides sanctipetri (Cuv. & Val.). King Sound.
Selaroides leptolepis (Cuv. & Val.). Onslow.
Acanthoperca gulliveri (Cast.). Ord River.
Loxolutjanus erythropterus annularis (Cuv. & Val.). Onslow.
Pomadasys maculatum (Bloch). Onslow.
Caprupeneus jeffi (Ogilby). Onslow.
Zabidius novemaculeatus (McCulloch). Onslow and Truscott.
Katsuwonus pelamis (Linne). Between Abrolhos and Geraldton, off Leander Reef and False Entrance and Point Cloates.
Parapomacentrus sp. nov. Cape Leveque.
Pseudopomacentrus fasciatus (Macleay). Cape Leveque.
Scarus fasciatus Cuv. & Val. Rat Island, Abrolhos and Shark's Bay.
Meiacanthus grammistes (Cuv. & Val.). Cape Leveque.
Clinus perspicillatus Cuv. & Val. North Beach.
Remilegia australis (Bennett). Bicton, near Fremantle.
Abcichthys praepositus (Ogilby). Near Broome.
Apistops caloundra (De Vis). Onslow.
Monacanthus (Sarothrura) hajam Bleeker. Between Cape Jaubert and Wallal.

Anoplocapros amygdaloides Fraser-Brunner. Cottesloe.
Paracanthostracion sp. Pelsart Island.
Liosaccus aerobaticus Whitley. Broome.

New Generic Names.

The following fishes, not all of them Westralian, require new generic names. For references, see Austr. Mus. Mem., v., 1929, and Neave's Nomenclator Zoologicus.

Achlyopa, nov. (Synapturidae). Orthotype, *Synaptura nigra* Macleay, 1880 = *Achlyopa nigra*. The Black Sole is not a *Synaptura* but is much nearer *Euryglossa* Kaup, 1858, but that is preoccupied by Smith, 1853, in Insecta.

Aidablennius, nov. (Blenniidae). Orthotype, *Blennius sphynx* Cuv. & Val. (Hist. Nat. Poiss., xi., 1836, p. 226) = *Aidablennius sphynx*. Equivalent to the "Sphynx" group of the subgenus *Salaria* Forskal (non-binomial) of the genus *Blennius* in Norman's Synopsis (Ann. Mag. Nat. Hist. (11) x., 1943, p. 801) and sufficiently distinguished there from typical *Blennius* (*ocellaris*) to deserve a new name.

Altiserranus, gen. nov. (Epinephelidae). Orthotype, *Serranus jayakari* Boulenger, Western Australian specimens. Distinguished from *"Epinephelus"* spp. by its long third dorsal spine, scaly maxillary, concave or truncate caudal fin, high body and plain coloration.

Bathypygidium, nov. (Pygidiidae). Orthotype, *Pygidium totae* Miles, 1942 = *Bathypygidium totae*. New name for *Bathophilus* Miles (Caldasia, v., 1942, p. 57), preoccupied by Giglioli, 1882, for another fish genus.

Eopeyeria, nov. (Tachysuridae). Orthotype, *Ariopsis aegyptiacus* Peyer, 1928 = *Eopeyeria aegyptiacus*. Replaces *Peyeria* Whitley (Austr. Nat., x., 1940, p. 242), preoccupied by Weiler, 1935, for a fossil sawfish.

Idiotropiscis, nov. (Syngnathidae). Orthotype, *Acentronura australe* Waite & Hale, 1921 = *Idiotropiscis australis*. Quite distinct from the Japanese *Hippocampus gracilissimus*, type of *Acentronura*, having the dorsal edges not continuous with those of tail, in body rings, etc.

Optivus, nov. (Trachichthyidae). Orthotype, *Trachichthys elongatus* Gunther, 1859 = *Optivus elongatus*. Allied to *Hoplostethus* Cuv. & Val., 1829, but differing in having the form more elongate, and only four dorsal spines instead of six.

Orbonymus, nov. (Callionymidae). Orthotype, *Callionymus* (*Calliurichthys*) *rameus* McCulloch, 1926 = *Orbonymus rameus*. From *Callionymus*, differs in its serrated preopercular spine and branched dorsal rays and from other Australian dragonets by the key characters given by McCulloch.

Penicipelta, nov. (Aleuteridae). Orthotype, *Monacanthus guntheri* Macleay, 1881 = *Penicipelta guntheri*. Distinguished from other Leatherjackets by the development of the remarkable brush of setae on each side of the body posteriorly.

EXPLANATION OF PLATE XI.

1. Sea Pike, *Sphyraena akerstromi* Whitley. Type.
2. Skipjack, *Ferdauia claeszooni* Whitley. Type.
3. Trevally, *Caranx papuensis* Alleyne & Macleay.
4. Oriental Bonito, *Sarda orientalis serventyi* Whitley. Type.

TESTING A SHARK REPELLANT.

By Gilbert P. Whitley and George H. Payne.

(Plates xii.-xiii., and text-fig. 1.)

"You may rest assured that the British Government is entirely opposed to sharks."

—Mr. Winston Churchill, in the House of Commons, February 20, 1945, referring to supplies of "Shark-Chaser" from the United States.

Sharks are probably the subject of more popular misconceptions than any other fish, due in part at least to the fact that scientifically and for that matter, commercially, they have been all but neglected until recent years. One fact, however, is only too well established—the shark is, at times, a man-eater, but unfortunately the conditions most favourable to shark attack, or the species most to be feared, are not known with any degree of certainty. More or less authenticated stories of shark attacks on men have been reported from most tropical and sub-tropical waters, and in this respect Pacific and particularly Australian waters have an unsavoury reputation. Though sharks have for many years been known to be man-eating in habit under certain circumstances, very little had been done until the outbreak of the recent war towards the development of any shark repellant material.(1)

This can be readily understood, as in peacetime possibilities of a man being forced into infested waters are remote, whereas under modern war conditions, not only sailors and airmen, but soldiers, as well, often find themselves in such a predicament, with conditions in many cases worsened by the presence in the water of blood from wounds.

The earliest reference to a possible repellant we have been able to trace dates back more than half a century to when an English parson, Jonathan Couch (1877, p. 29), noted, concerning the Blue Shark, *Carcharhinus glaucus* (Linné):—

> "It appears that this fish pursues its prey by sight rather than by scent, although its nerve of smelling is of large size; but it is known to be sensible to a nauseous smell or taste, for fishermen assert that it may be driven away by pouring bilge-water into the sea, where it

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(1) Repellant or repellent? We find ourselves spelling it both ways, but here we must be consistent, and so we use repellant. The Oxford English Dictionary does not state which it favours, but quotes "repellant" used as a substantive as far back as 1689; "repellent" as a noun is now considered rare, although common as an adjective, and is the only spelling given in some dictionaries. The learned "Walrus," in one of his delightful articles in the "West Australian" (6/1/1945), side-steps the issue thus: "If the proof-reader does volunteer an explanation, I shouldn't be surprised if he tells me that he got the idea of the spelling from a doctor's prescription. And in that mystic document it might have looked repellant even though it wasn't intended to be. Anyhow, I hope when he next encounters the repulsive word, he won't mark the proof *rep. mist.*"

is: a piece of information that may be of use in reference to the still more destructive White Shark."

These remarks are valuable because they refer to a Galeid Shark, allied to the dangerous Whaler Sharks; the bilge-water of those days would presumably be free of products from motor engines.

Couch's observations would have been made about the 1820's. The 1862 first edition of his work is not available to us.

Work on the development of a suitable shark repellant appears to have been initiated in the United States of America early in 1942. The original investigators worked mainly on the principle that a shark is virtually a swimming nose, and that it is attracted to food solely by the sense of smell. The physiology of the shark certainly supports this view, and consequently early efforts were concentrated largely on the discovery of a chemical which would act as an intense nasal irritant and so interfere with the animal's sense of smell. Very many different substances were tried, but best results were obtained by following the clue of fishermen's reports that sharks would not go near other sharks which had been left dead in the sea after capture on lines.

First successes were achieved when a chemical was discovered that discouraged dogfish kept in large tanks from feeding, and the results so obtained were later verified by field tests carried out in the Gulf of Guayaquil, Ecuador, and subsequently in waters off Havana and Florida.

Later experiments carried out both in U.S.A. and New Zealand indicated that a mixture of this chemical (normal copper acetate) and a black or dark blue dyestuff provided still more efficient protection against shark attack than the original chemical alone, and it is this combination which is now used as the basis of Service Shark Repellant Units.

Though the constituents of the repellant unit as developed in America had been shown to give a high degree of protection against sharks common in American waters, it was considered desirable by the R.A.A.F. to confirm their action when used in the presence of the more dangerous Australian, South-west Pacific and East Indian varieties. In addition, the repellant had to be modified to meet local conditions as regards the supplies of raw materials and manufacturing facilities.

In 1944, a joint Royal Australian Navy and Royal Australian Air Force Committee in Melbourne required tests of substances which had been evolved by American, New Zealand and Australian chemists to ascertain whether or not they would repel sharks. Flight-Lieutenant G. H. Payne, R.A.A.F., Melbourne, did the chemical work; Mr. G. P. Whitley, Research Officer, C.S.I.R., Division of Fisheries, organised the expedition and identified the sharks; Mr. James Goodlad, Fisheries Inspector of the W.A. State Fisheries Department, was in charge of fishing and boat operations. The R.A. Navy arranged for gear to be provided and the R.A.A.F. arranged for transport and air travel; Mr. S. Fowler, of the C.S.I.R., Division of Fisheries, performed helpful aerial reconnaissance in a R.A.A.F. aeroplane. An Army observer, Major C. S. Murray, accompanied us on some of our cruises.

After a series of preliminary chemical tests had been conducted at the University of Sydney, experimental batches of repellant tablets were manufactured in Melbourne and practical tests carried out in the appropriately named Shark's Bay, Western Australia. This area was chosen as being most suitable for the conducting of controlled experiments and because the

sharks frequenting those waters were representative of those species met with in the waters of Pacific operational areas.

The tests were carried out from a 70 ft. lighter, and were conducted during seven cruises of from two to six days' duration each, between July and September, 1944.

A line up to half a mile in length was anchored at each end across the direction of the prevailing current, and fitted with buoys in such a way that for most of its length it was a few feet below the surface. Large jewfish hooks, baited with fresh fish, were usually set 60 ft. apart at depths of four to six feet below the surface, each alternate bait having suspended just above it a meshed bag of repellant tablets which immediately on immersion dyed the water in the vicinity. (The "Shark-Chaser" Unit developed by the U.S. Army was of different design but similar principle.)

Various rigs of floating set-lines were used, the idea being for each bait to simulate an airman floating in the water, with charges of repellants (of one or more kinds) and "control" baits with no repellant at all.

Sharks were encouraged into the vicinity of the test-lines by the blood of captured sharks, turtles, and dugong, all of which were used as bait, in addition to snapper, mullet and other fishes. The big majority of the catches was made at night, and removing two or three resentful 10 ft. sharks from somewhere along half a mile of line on a cold and windy midnight was not without excitement.

During the 500 hours for which the lines were down, for one hundred experiments, a total of 50 sharks was caught. Of these, 80 per cent. were caught by night (between 1700 and 0700 hours) and 20 per cent. by day (0700 to 1700 hours) catches being nearly three times as frequent during hours of darkness as during the daylight hours. The tides did not make any apparent difference to sharks feeding, only a few more than half of the sharks being taken on the ebb tide.

The sharks caught ranged from 3½ to 12½ feet in length, mostly around the 6 ft. mark, and belonged to three genera, all suspected as potential man-eaters, and likely to be encountered in operational areas northwards of Australia or in the Western Pacific. In order of abundance, our results were:—

Species.	*Percentages of Strikes.*
Tiger Sharks, *Galeocerdo cuvier*	34.
Sand Sharks, *Galeolamna dorsalis*	34.
Inkytails, *Longmania calamaria*	12.
Whalers, *Galeolamna greyi cauta*	4.
Sharks escaped, or baits with shark-bite marks	16.

Some of these species were new to science at the time, but have recently been described and figured in the "Australian Zoologist."

The repellant materials were in the form of small tablets and consisted of two types, made up essentially of a black dyestuff (2) (type A or "black

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(2) The dye used in our Western Australian experiments is known in the trade as "Methic Leather Black D.G.," a mixture of several basic dyes whose formulae are not revealed by the makers. The main merit of repelling sharks is, however, credited to the copper acetate, and not to the dye, though the deep staining of the water by the latter would doubtless have a comforting psychological effect on a stricken swimmer.

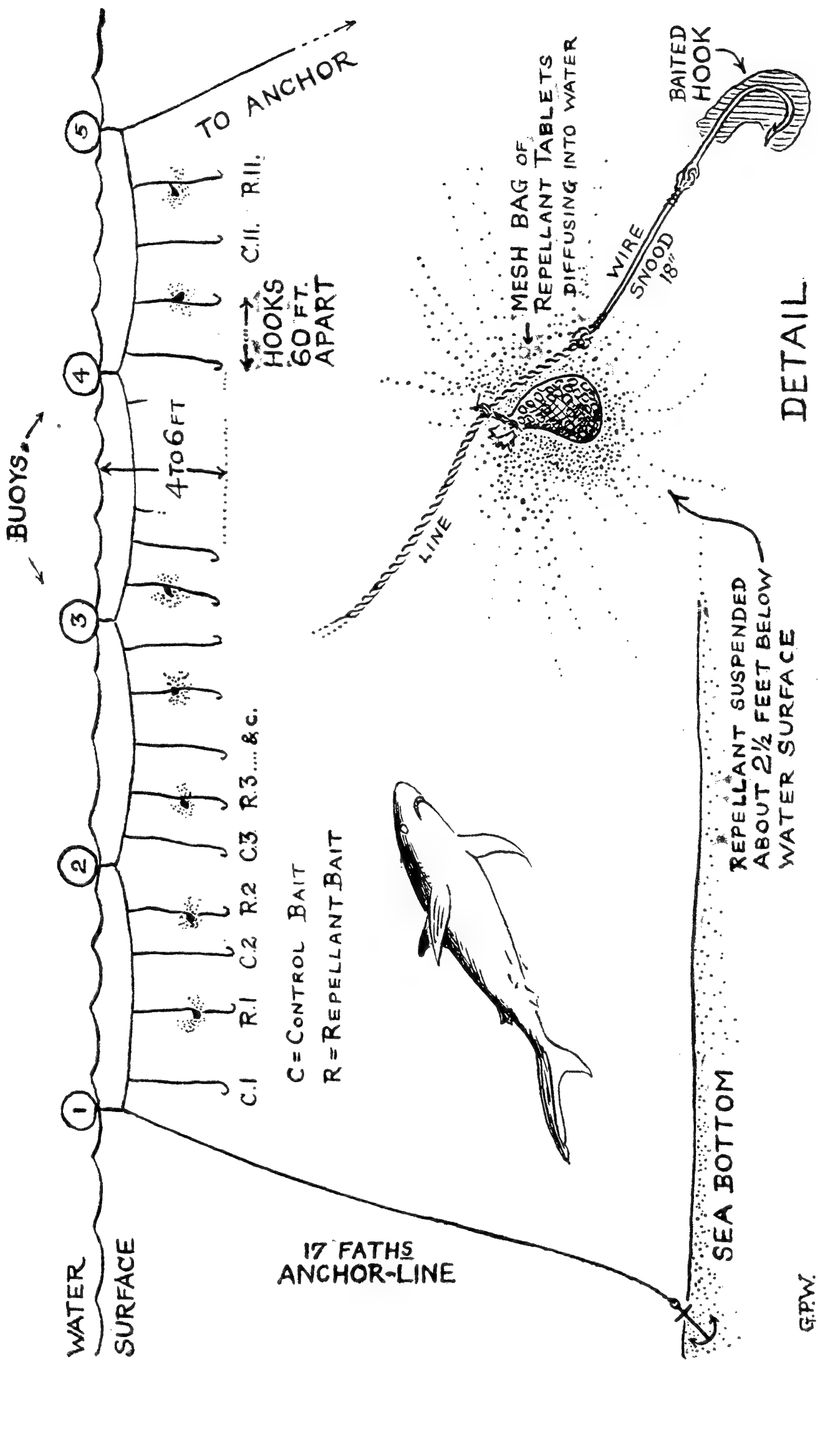

Fig. 1. A typical rig of the set line used in shark repellant tests. Diagrammatic, not to scale.
—G. P. Whitley, del.

magic") and copper acetate (3) (type B) respectively. A repellant charge consisted of either 3 oz. of type A alone or a combination: 3 oz. of type A plus 4 oz. of type B. The life of a repellant charge was found to vary according to strength of current and roughness of water and size of tablets.

Generally the 3 oz. charge of dye tablets would last at least 12 hours while the life of the copper acetate charge was between three and four hours.

We, therefore, had to overhaul all our hooks and lines at 3-hourly intervals, day and night, wet or fine, to replace dissolved charges and record results. This was arduous, and even the interim routine work of washing bags, and weighing or counting out the tablets, whose pungency was irritating, were tests of our patience. Then the struggles of man-eaters, hauled into our little dinghy and clubbed on the nose, often tangled the lines so much that they had to be dumped aboard the lighter, the numbered hooks carefully sorted, and results analysed before the next set, this work sometimes having to be done by lamp-light. The sharks were each dissected afterwards and information on their feeding and breeding obtained.

The effectiveness of a repellant was calculated according to the following formula, devised by Stewart Springer, of Florida:—

$$\frac{\text{Number of sharks on control minus number on repellant}}{\text{Number on control.}} \times 100 = \%\ \text{effectiveness.}$$

An observed strike by a shark was counted, even though the shark may not have been hooked and landed. Thus, using A type alone, we found on repellant baits 9 sharks, on control baits 19, giving effectiveness of 52.6 per cent.; using A + B, on repellant baits 1, on controls 21, giving an effectiveness of 95.2 per cent.

The possible effects of the chemical repellant on a man in water were tested by swimming submerged and with open eyes through water impregnated with repellant. No ill-effects were suffered.

A further point of interest is that, whereas sharks would not take a bait in the vicinity of the repellant, no trouble was experienced in hooking snapper and other table fish on ordinary hand-lines to which a shark repellant had been tied just above the bait. Neither did repellant placed in shallow water thickly populated with tiny school fishes harm them in any way, and no complaints were made by fishermen that their livelihood was affected by our experiments.

The work was at times greatly facilitated by aerial spotting. Obviously sharks as well as schools of fish are more readily located from the air than from water level, and with a plane from the nearest R.A.A.F. stations periodically flying over the area to locate concentrations of sharks, we were able to conduct our tests with a minimum of time lost in blind searching.

As a result of these tests, it has been conclusively shown that the materials tested possess properties repellant to the varieties of sharks most common in Western Australian waters. Tests by other workers having shown that similar materials are effective against sharks frequenting the waters around Ecuador and Florida, and in New Zealand and elsewhere, it seems reasonable therefore to conclude that a universal shark repellant

(3) Normal copper acetate, $Cu\ (C_2H_3\ O_2)_2.H_2O$.

material has been discovered and its issue to the R.A.A.F. as a result indicated that airmen forced to bale out over shark-infested waters had at least one less hazard to face in their struggle to regain safety.

Since the end of the war, shark repellants have been adopted at some surf carnivals and swimming races off Australian beaches. A tribute to the value of shark repellant in saving fishermen's gear, whilst not affecting fish, comes from the *Canadian Fisherman*, November, 1945. We thank Mr. S. Fowler, who had originally pointed out to us from the air the occurrences of sharks during our Shark's Bay experiments, for calling our attention to this reference.

Sharks that had been attacking netfuls of mackerel off the Massachusetts coast and causing damage to gear and much loss of fish were successfully repelled by fishermen using the chemical "Shark Chaser" issued to American Servicemen during the war. Two blocks of the deterrent were sunk to a depth of 20 to 30 feet and towed around the net. "The sharks headed for the net, but as soon as they hit the black slick formed by the 'Shark Chaser' they were noted turning and swimming away from the net." The boat whose crew had been thus enterprising received no damage to its nets and caught about 58,000 lb. of mackerel. Other boats without protection averaged only 5,000 to 25,000 lb. of fish and suffered severe damage to their nets.

It looks as if Shark Repellants have come to stay.

It may be of interest to append here an incantation used in the Solomon Islands when protecting a man in a canoe from sharks. As given by Dr. Walter G. Ivens (1927, p. 237), it is:—

"That I may win praise this day
I shall rescue the dear one this day:
This is thy charm, Lord Awao
This is thy charm, Awao-throwing-gall-on-sharks. . . ."

The "gall" was not actually used as a repellant by the Islanders, but only a magical formula or ritual. However, it is interesting to note that the idea of some kind of shark repellant occurred to the primitive Melanesians.

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EXPLANATION OF PLATES.

Plate xii.

Map of Shark's Bay, Western Australia, showing route taken and cruises (numbered) during shark repellant tests.

Plate xiii.

1. The lighter from which tests of repellants were carried out in Shark's Bay.
2. A large Tiger Shark caught near Dirk Hartog Island.
3. A 10 ft. Tiger Shark from Shark's Bay.
4. Left to right: Payne, Whitley and Goodlad returning from overhauling the set lines.
5. Two sharks which took baits unguarded by repellants.

—Photos by G. H. Payne, C. S. Murray, and G. P. Whitley.

OBSERVATIONS ON THE TOOTH-BILLED BOWER-BIRD (*SCENOPOEETES DENTIROSTRIS*).

By MAURICE F. LEASK, Memb. F.N.C.V.

These notes are prepared with Cayley's "What Bird Is That?" on hand, and are intended as an elucidation of the description therein.

On November 14, 1943, at 2 p.m., we were following a disused jungle path, about a mile east of Lake Eacham, on the Atherton Tablelands of North Queensland. Continued bird calls attracted our attention. They came from a spot 30 yards off the track, and resembled parrot's cries, varied and tending to warbling. The bird was located close to the ground, and identified as the Tooth-billed Bower-bird. Compared with the book-plate, the bird was more distinctly speckled underneath and more strongly, sheeny brown on the upper side. At the spot where the bird was first located was a cleared patch of earth, with no green leaves thereon, and situated beside a mass of lawyer cane, forming loops two feet high. It is probable that the bird perched on these loops at intervals; the absence of green leaves indicates that this bird was just beginning its mating activities.

Half a mile to the east, near the top of a slope in the middle of dense scrub, a second bird was heard emitting similar notes. It, too, was close to the ground. On flushing, it flew a short distance only, and was seen to be identical with the former. At the spot from which it rose was a cleared patch of earth about 3 ft. by 4 ft., and on this were a dozen fresh leaves, all apparently similar. This cleared spot was made between six tiny growing saplings, two feet high, with stems ⅛ inch in thickness.

On November 23, 1943, we paid a second visit to the same locality at 7 p.m. in the last hour of daylight for the express purpose of guilding Capt. A. J. Marshall to the playgrounds. At the first spot the bird was repeatedly twittering, rather like the imitation of a parrakeet. When Capt. Marshall made a sucking sound, a pair of birds responded by flying excitedly nearer and making a call similar to his. The cleared space had over a dozen leaves on it, placed underside uppermost, *i.e.*, whitish side up. They are said to be similar to the leaves used in the Cape York area, namely, *Litsea* leaves. *Litsea* is a Brown Bollywood of the family Lauraceae, occurring at intervals in the fringing jungle from Eungella to Cairns, and possibly further north. (Swain.)

One of the leaves under examination was very fresh, being much whiter; all gave the impression of being pressed to earth, as though by the bird's feet.

The second playground was re-visited; it was indicated by the bird calling in a twitter as abovementioned. The cleared space had over a dozen fresh leaves arranged on it. Scratchings on the circus-ring were made, probably by bandicoots. A pair of birds responded in the same way as at Site I. to Capt. Marshall's sucking sound.

In conclusion, it will be noted that no description of the display can yet be given. There appears to be an extended range of the Tooth-billed Bower-bird. A discrepancy appears to occur in the species of leaves or in Swain's range of the *Litsea*.

It is expected that further more scientific records of this bird will be given by Capt. Marshall in due course.

SOME NOTES ON LEPIDOPTERA COLLECTED AT DARWIN DURING NOVEMBER, 1945.

By J. O. Campbell.

While serving on H.M.A.S. *Warrego,* I called into Darwin several times and captured over two hundred specimens of twenty different species and recorded three others on the wing during the month of November.

We first arrived there on November 2 and up till then no rain had fallen for many weeks.

Very few specimens were flying about with the majority of these badly damaged. All told I caught eight specimens worth mounting and recorded six different species during the day.

A week later I managed to land on the afternoons of November 7 and 8 to find that collecting had improved slightly for heavy rain had fallen while I was absent.

I caught a number of specimens around the coastal area of Darwin, chiefly near the Sportsground, and on a hillside above the Naval Boom Depot.

On November 9, I left with a recreation party for 24 hours' leave to be spent at Knight's Cliff, six or seven miles east of Darwin and on the coast. In a small patch of scrub near our camp, I managed to catch a number of specimens of sixteen different species, the commonest being *Papilio fuscus canopus,* of which I took eighteen perfect specimens. Half a mile from the camp was a river and mangrove swamp along the edge of which I caught three fine *Amblypodia centaurus asopus.*

The collecting area at Knight's Cliff was mostly open scrub with small trees and patches of flowering lantana which attracted a number of specimens. Wallabies were quite common in this area.

My next opportunity for collecting was on November 28 and 29, when the wet was well under way. Lush grass had sprung up everywhere and fresh growth had started on most of the trees. A common feeding-plant about the town was a daisy-like flower, very plentiful around the bombed post office. A pink flowering vine growing in the gullies and on the fences was also visited frequently. Many of the trees were in flower and several at the back of the Administrator's residence provided some good collecting, but a long-handled net was necessary. Around these trees, in the grass beneath, and along the roadside were many larvae and pupae of *Melanitis leda bankia* and several Skippers. The butterflies themselves were plentiful also.

The Administrator's garden and the Darwin Botanical Gardens provided me with many specimens during January and February of 1942. During the following years these places had been neglected and large masses of barbed wire made collecting almost impossible.

On my previous visit I failed to keep a diary on the prolific collecting of the autumn months and consequently have no notes to fall back on for reference.

While in Darwin I saw a fine specimen of *Eriboea pyrrhus sempronius* in a naval man's collection, but failed to take it myself.

A list of specimens seen and collected:—

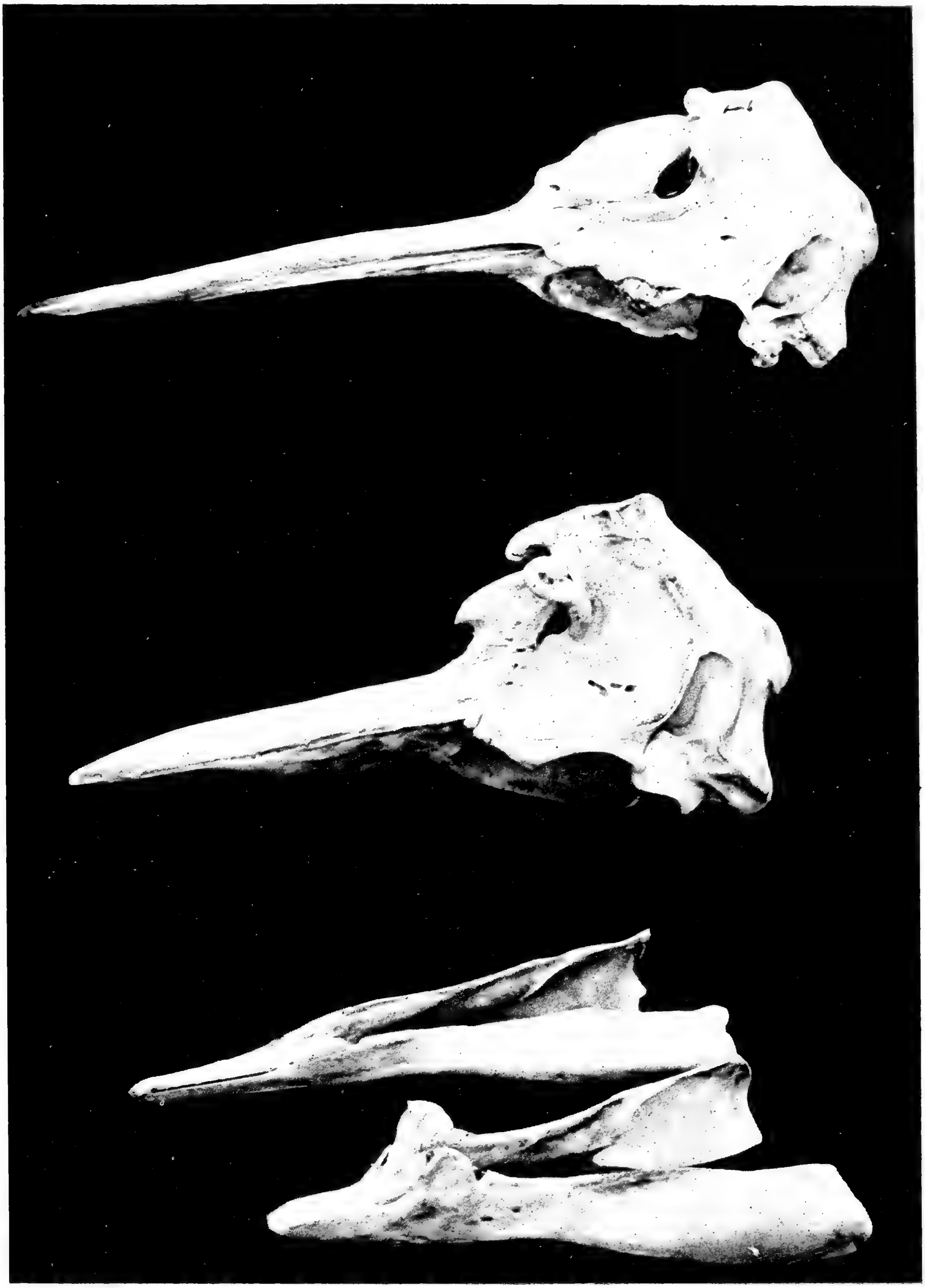
Papilio fuscus canopus Westwood, 1842.
Papilio eruypylus nyctimus Waterhouse and Lyell, 1914. (A fine pair taken while copulating.)
Eurycus cressida cassandra Waterhouse and Lyell, 1914.
Terias smilax Donovan, 1805.
Terias hecabe sulphurata Butler, 1875.
Terias laeta lineata Miskin, 1889.
Appias paulina ega Boisduval, 1836.
Ellodina perdita walkeri Miskin, 1889.
Catopsilia pomona pomona Fabricius, 1775.
Anaphaeis java teutonia Fabricius, 1775.
Danaida chrysippus petilia Stoll, 1790.
Danaida affinis affinis Fabricius, 1775.
Danaida melissa hamata Macleay, 1827.
Euploea corinna corinna Macleay, 1827.
Euploea tulliolus darchia Macleay, 1827.
Euploea sylvester pelor Doubleday and Hewitson, 1847.
Acrea andromacha Fabricius, 1775.
Hypolimnas bolina nerina Fabricius, 1775.
Cethosia penthesilia paksha Fruhstorfer, 1905.
Precis villida calybe Godart, 1819.
Precis orithya albicincta Butler, 1875.
Melanitis leda bankia Fabricius, 1775.
Hypocysta adiante antirius Butler, 1868.
Mycalesis sirius sirius Fabricius, 1775.
Amblypodia centaurus asopus Waterhouse and Lyell, 1914.
Boaris impar lavinia Waterhouse, 1932.
Ocybachstes tanus nihana Fruhstorfer, 1911.

Also two unidentified Skippers, making twenty-nine species all told.

AN EARLY EVOLUTIONIST.

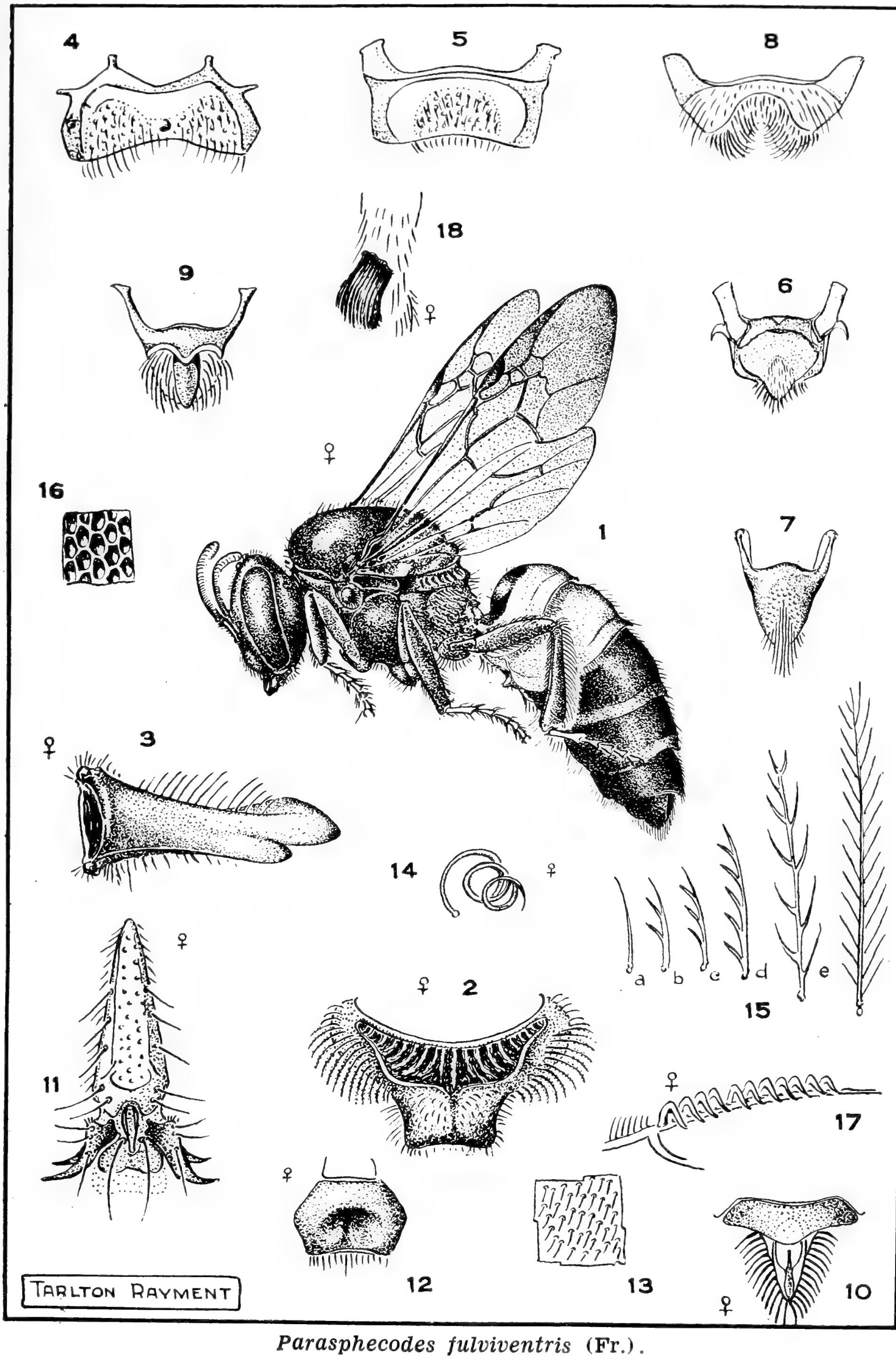
Though the main Theory of Evolution is rightly credited to Charles Darwin, whose "Origin of Species" was published in 1859, there were thinkers whose ideas ran very close to the lines of Darwin's theory long before the latter was propounded. One of these was that erratic but illustrious genius, C. S. Rafinesque (1783-1840), who, as far back as 1832, remarked:—

"The truth is that Species, and perhaps Genera also, are forming in organised beings by gradual deviations of shapes, forms and organs, taking place in the lapse of time. There is a tendency to deviations and mutations through plants and animals by gradual steps at remote irregular periods. This is a part of the great universal law of perpetual mutability in every thing." (Quotation from the *American Naturalist,* lxxix., 1945, 84.)

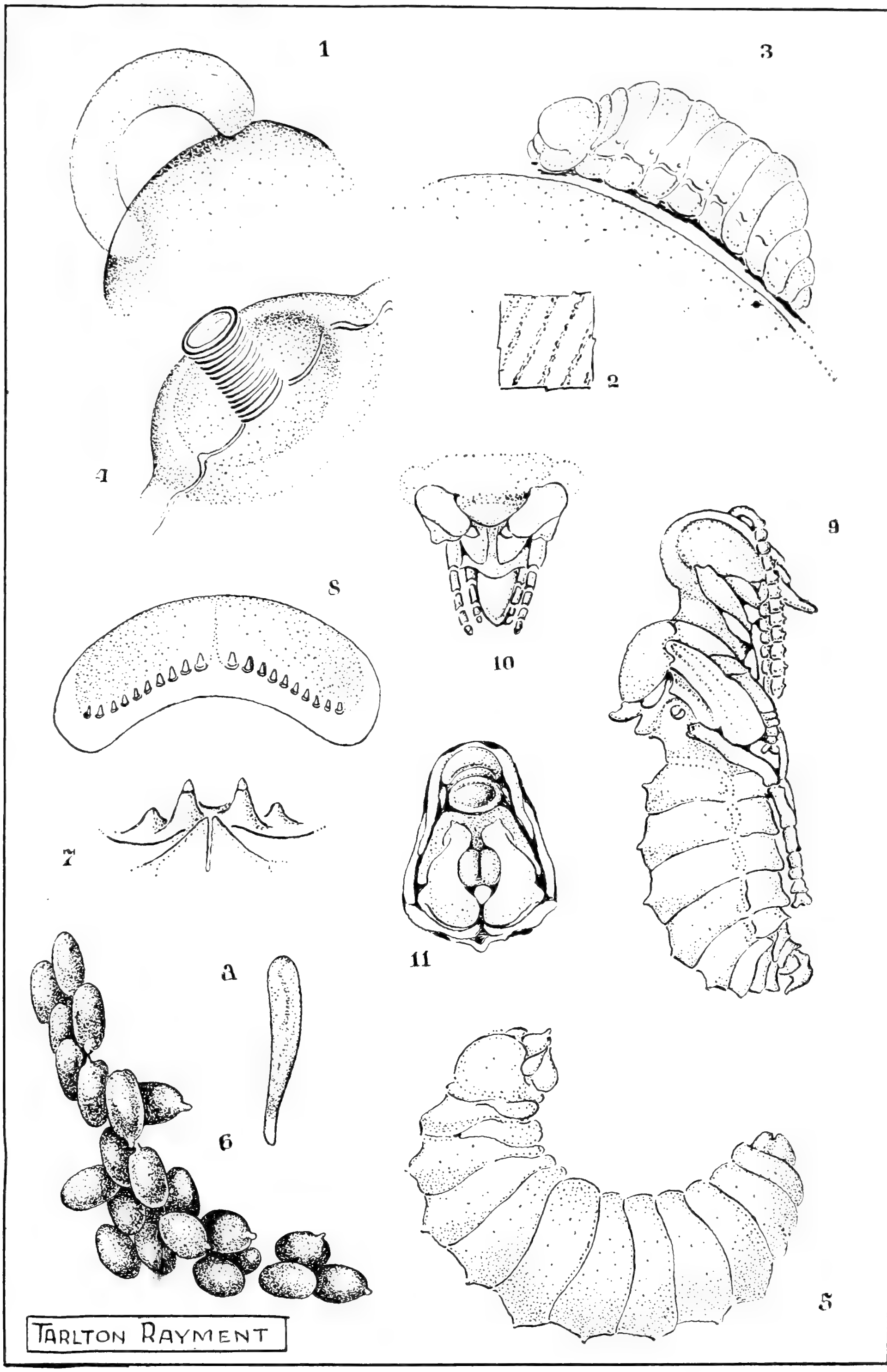


Beaked Whales.

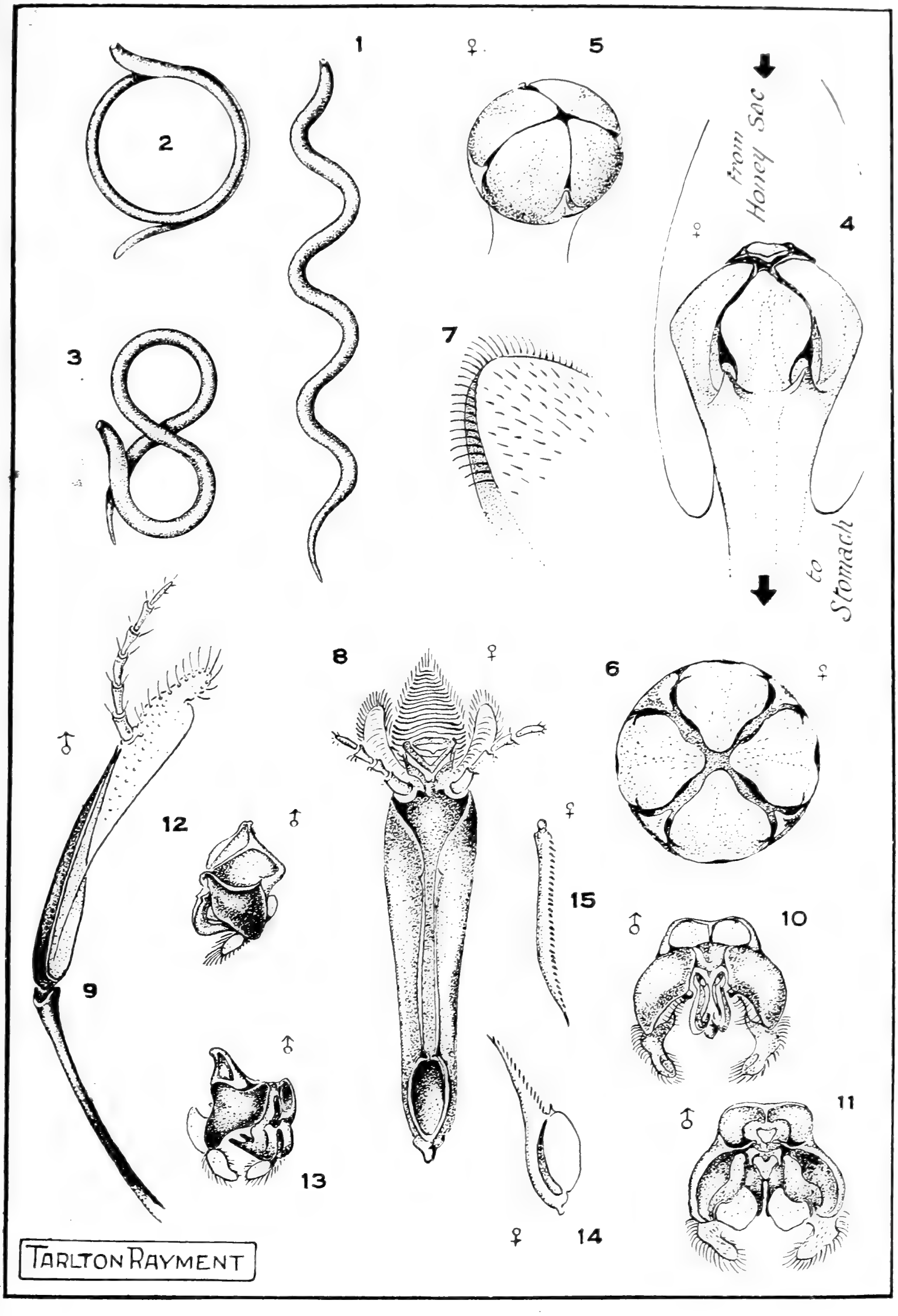
Stanley Fowler, photo.



Parasphecodes fulviventris (Fr.).



Parasphecodes fulviventris (Fr.).



Parasphecodes fulviventris (Fr.).

Frederick Strange—after Maiden.

Railway cutting occupied by the huge colony of *Parasphecodes fulviventris* (Fr.).

Tarlton Rayment, photo.

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2

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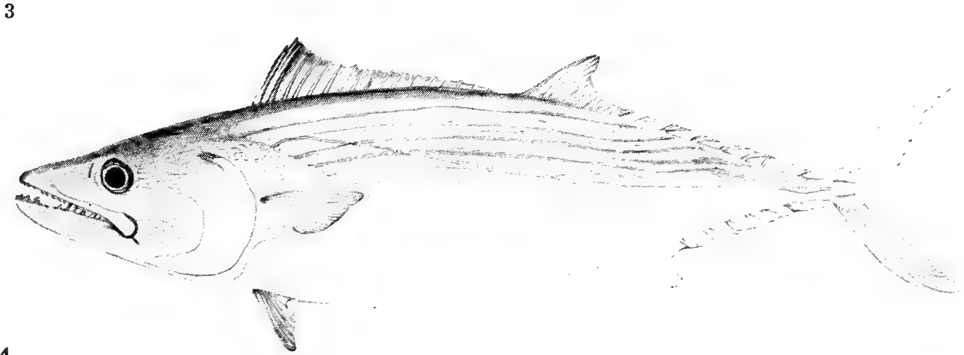

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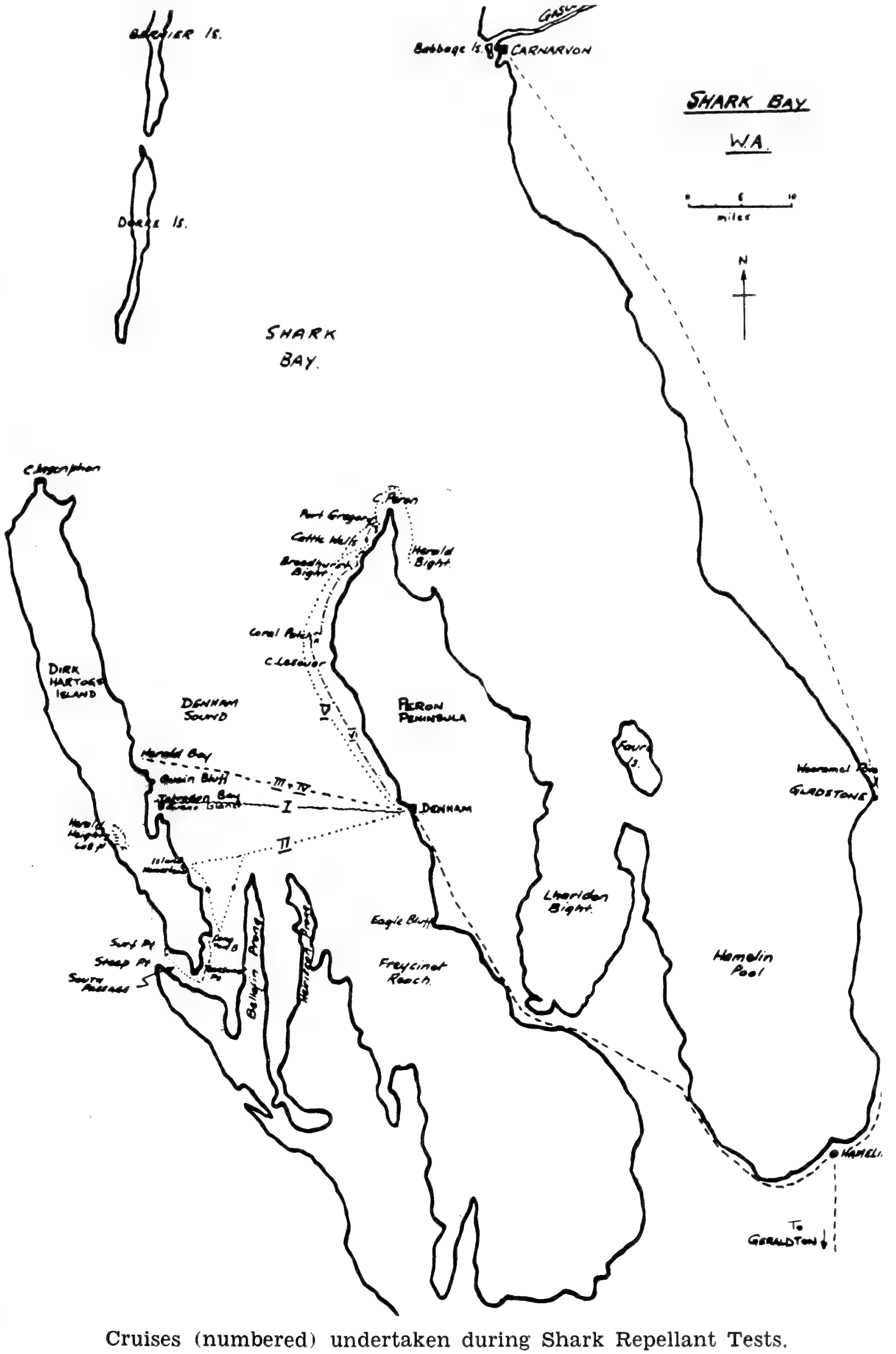
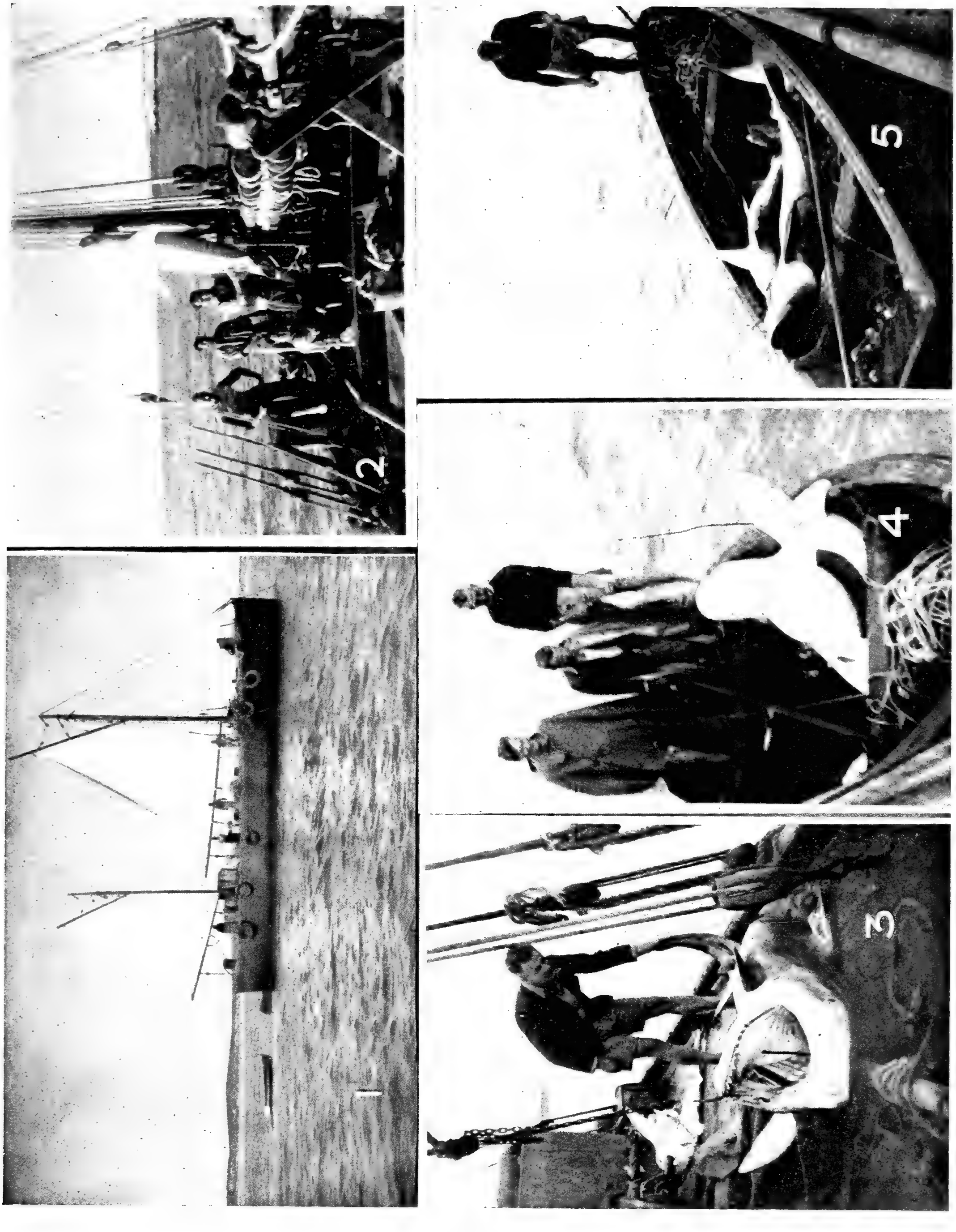
Western Australian Fishes.

G. P. Whitley, del.



Cruises (numbered) undertaken during Shark Repellant Tests.



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Vol. XI. Part 3.

A CHECK LIST OF THE BIRDS OF PARADISE AND BOWER-BIRDS.

By Tom Iredale.

Captain N. B. Blood, patrolling the highlands about Mount Hagen, north-eastern New Guinea, became interested in the number and variety of Birds of Paradise in the country. He collected a series on behalf of the Australian Museum and the variety was really astonishing, as no fewer than nineteen species were represented, and some were found to be difficult to determine. It may be noted that this was the country of that wonderful species, the Ribbon Tail, which really first attracted him, although the Blue Bird was almost as interesting. The difficulty of identifying these birds was also due to the lack of any work giving good coloured illustrations, as none had appeared for fifty years. Much collecting had been done in the meanwhile, so the task of bringing the available knowledge into perspective was undertaken. Coloured figures of all the named species have been made and the account will be published this year. The most important matter otherwise was the preparation of a Check List, as the last one was fifty years old. In 1898 three listings were issued, one by Sharpe at the conclusion of his Monograph, another by Meyer when he exhibited a series of the birds before the Ornithological Congress, and Rothschild described the species briefly without figures in Das Thierreich. Since then Rothschild maintained his interest in this group and many papers were issued by him, sometimes in conjunction with Hartert, on the subject. The British Ornithologists' Expedition's finds were reported upon by Ogilvie-Grant in 1915, and recently the Archbold Expeditions have contributed to our knowledge of distribution. Blood's contribution is even more amazing as to distribution.

The Birds of Paradise and Bower-Birds are all included in Mathews' Systema Avium Australasianarum, wherein he apparently followed Sharpe's classification, and a good synonymy for the time was given. Mayr has recently issued a List of New Guinea Birds in which, of course, all the New Guinea forms are included, but no fewer than twenty species are written off as "Hybrid Birds of Paradise", apparently without many facts to support the suggestion. The present list allows the species as proposed, until facts negative their status, hypothetical and sometimes fantastic parentage being ignored.

The following new species and subspecies are introduced here, but full descriptions and coloured figures will appear in the account now in the press, the references to plates and figures given after each bird's name being to that work.

Paradisea bloodi, new species. This is one of the most beautiful forms yet discovered and was collected at Minyip, Mt. Hagen, by Captain Blood. Top of head dark orange brown, frontal band small, black with a blue tinge, throat patch large, small scale-like feathers with iridescent sheen, deep violet, throat band large, wide, red-brown with purplish tinge, a breast cushion of deep brown with a purple tinge, rest of under surface brown with a blue wash, back feathers bluish brown, wings similar, coverts with a bronze tinge; tail feathers blue, streamers narrow webbed both sides, black with dull blue tip. The side plumes are long, loose, stiffish, lower ones basally crimson, ends brownish blue, upper series fawn, with a greenish tinge. Bill, 32 mm.; wing, 178 mm.; tail, 130 mm.; tarsus, 40 mm. The bill is shining dark grey, the eye brown, legs dark slate. In detail this bird has the bill long, deep, interramal space very small, wing with first primary narrow, tip slightly attenuate, as is the second, the fifth and sixth

longest, secondaries long but not as long as the primaries, the tail rounded, feathers square, central pair very long, a web about 1 mm. broad on each side, the outer slightly the larger, the tip a little broader and rounded.

As this bird is not a typical *Paradisea*, a subgenus, *Visendavis*, is here proposed for it until more is known about it, the structures described above being diagnostic.

ASTRARCHIA BARNESI, new species. This beautiful bird is named after Mr. William Barnes, of the Australian Museum, as it is almost entirely due to his enthusiasm that Captain Blood made the collection here noticed. It has the general form and colouring of *A. stephaniae* but has a shorter bill with a different tail structure. The tail feathers are pointed, narrow and comparatively short, the longest feather, except the middle pair, being 130 mm. with 18 mm. width, whereas *stephaniae* shows 180 mm. with 28 mm. width. The two long feathers are longer than in *stephaniae*, 750 mm. and over, the very longest *stephaniae* not reaching 700 mm., but are differently formed. In this bird the base is very narrow, 12 mm., with a very broad white shaft, broadening out to 40 mm., while *stephaniae* has a small narrow white shaft, though it measures 40 mm. at base and over 70 mm. at widest part. These central feathers are boldly marked with white, which *stephaniae* never shows. Mt. Hagen district.

LOPHORINA SUPERBA ADDENDA, new subspecies. The forms of *superba* so far separated have depended mostly on the colour of the female and the frilling of the nape ornament, but no mention has been made of the structure of that, which in the type is erected as a large ∽ shaped fan; in *minor* from the south-east the fan is a squarish oblong, but in the present form it is a very large crescent with very long fringes, the breadth being 290 mm. The breast shield is also very large, with an extent of 190 mm. The frontal tufts are like those of *minor*. The feathers of the breast shield in the middle bear black central streaks as reported for *minor*, but Arfak birds also show this feature, which must be dismissed as diagnostic. Bill from nostril, 18 mm.; wing, 125 mm.; tail, 92 mm.; tarsus, 34 mm. Mt. Hagen district.

PAROTIA LAWESI EXHIBITA, new subspecies. The male agrees in detail with that of *P. lawesi*, with practically the same measurements, while the female is not unlike that of *lawesi* on the upper surface, a little darker, more uniform, but the under surface shows easy distinction, as it is rufous, strongly closely barred from chin to undertail coverts with narrow blackish brown bands: in *lawesi* the bars are fairly close on breast but become weaker on sides of breast and obsolete on abdomen and undertail coverts. Bill from nasal groove, male 15, female 15 mm.; wing, male 160, female 152 mm.; tail, male 80, female 110 mm.; tarsus, male 48, female 45 mm. The birds are from Hoiyevia, 5,500 feet, Mount Hagen district.

CNEMOPHILUS MACGREGORII SANGUINEUS, new subspecies. This form has replaced the golden yellow of the type with scarlet vermilion, the cinnamon brown of the wings and tail being very much darker and more reddish. The female has a crest as long as that of the male, duller coloured, and her coloration above curiously lacks the reddish brown tinge of the type, being olive green, while underneath the throat is pale, the breast darker green and the abdomen pale yellow. The measurements of both sexes are similar. The type male was procured at Kumdi, another male at Moyani, 8,000 feet, and two females at Lake Iviva, 7,850 feet, all in the Mount Hagen district.

QUESIPARENS, new genus. Introduced for *Paradisea mirabilis* Reichenow, from which genus (*Paradisea*) it differs in bill and tail characters, which Reichenow compared as to the former with that of *Seleucidis*, and the latter with *Paradisea*, but without the two streamers; the two central feathers normal but lengthened a little.

LOBOPTILORIS, new genus. Proposed for *Loborhamphus ptilorhis* Sharpe, which differs from *Loborhampus*, as stated by Sharpe, in its larger size, the frontal tuft, lack of chin tuft, absence of nuchal frill, and different breast shield.

Class AVES.	BIRDS.
Order PASSERIFORMES.	PASSERINE BIRDS.
Family PARADISEIDAE.	BIRDS OF PARADISE (so-called).
Subfamily PAROTIINAE.	RIFLE BIRDS AND THEIR ALLIES.
Genus PTILORIS Swainson.	TRUE RIFLE BIRDS.

1825. *Ptiloris* Swainson, Zool. Journ., vol. i, pt. iv, p. 479, Jan. Haplotype *Ptiloris paradiseus* Swainson.

Name also spelt *Ptilorhis* Agassiz, 1846 (Index Univ., 12mo. ed., p. 913); *Ptilorhys* Bonaparte, 1854 (Comptes Rendus Acad. Sci. Paris, vol. xxxviii, p. 260); *Ptilornis* Gray, 1870 (Handl. Gen. Sp. Birds, vol. i, p. 104); and *Ptilorrhis* Newton, 1894 (Dict. Birds, pt. iii, p. 790).

PTILORIS VICTORIAE Gould. Plate i, figs. 1, 2. QUEEN VICTORIA RIFLE BIRD.

1850. *Ptiloris victoriae* Gould, Proc. Zool. Soc. (Lond.), 1849, p. 111, Aves, pl. 12 (between Jan. and June, 1850); Barnard's Isles, North Queensland (J. Macgillivray).

1915. *Ptiloris paradisea dyotti* Mathews, Austral. Avian Rec., vol. ii, p. 133, Jan. 28. Cairns, North Queensland.

Figured by Gould, Birds Austr., Suppl., pt. i (pl. 50), Mch. 15, 1851; Elliot, Mon. Parad., pl. 26, 1873; Sharpe, Mon. Parad., vol. i, pl. 2 (pt. iii), 1894; Mathews, Birds Austr., vol. xii, p. 372, pl. 591; 1926; described, Rothschild, Paradis., p. 24, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 867, 1930.

PTILORIS PARADISEUS Swainson. Plate i, figs. 3 and 4. RIFLE BIRD.

1825. *Ptiloris paradiseus* Swainson, Zool. Journ., vol. i, pt. iv, p. 481, Jan.; Lake Macquarie, New South Wales.

1825. *Epimachus regius* Lesson, Ann. Sci. Nat. (Paris), vol. vi, no. 23, p. 263, November; Port Macquarie, New South Wales; id., Lesson and Garnot, Voy. Coquille, Zool., Atlas, pl. 28 (livr. 1), Nov. 1, 1826; p. 667 (livr. 15), Apl. 3, 1830.

1827. *Epimachus brisbanii* Wilson, Illustr. Zool., pt. iii, pl. xi (end); Port Macquarie, New South Wales.

1923. *Ptiloris paradisea queenslandica* Mathews, Austral. Avian Rec., vol. v, p. 42, Feb. 21; Blackall Ranges, South Queensland.

Figured by Gould, Birds Austr., pt. xxvii (vol. iv, pl. 100), June 1, 1847; Elliot, Mon. Parad., pl. 25, 1873; Sharpe, Mon. Parad., vol. i, pl. i (pt. ii), 1893; Mathews, Birds Austr., vol. xii, p. 366, pl. 590, 1926; described, Rothschild, Paradis., p. 24, 1898; listed Mathews, Syst. Av. Australas., pt. ii, pl. 867, 1930.

Genus CRASPEDOPHORA Gray. NEW GUINEA RIFLE BIRD.

1840. *Craspedophora* Gray, List Gen. Birds, 1st ed., add. p. 1, April. Orthotype *Falcinellus magnificus* Vieillot. (Not *Craspedophorus* Hope, Coleopt. Man., vol. ii, pp. 91, 165, 1838.)

1922. *Mathewsiella* Iredale, Bull. Brit. Orn. Club, vol. xliii, p. 39, Nov. 29. Orthotype *Craspedophora magnifica claudia* Mathews.

1931. *Pherocraspedon* Mathews, Bull. Brit. Orn. Club, vol. lii, p. 25. To replace *Mathewsiella* Iredale, 1922, not *Matthewsiella* Hetsckko, 1913.

CRASPEDOPHORA MAGNIFICA Vieillot. Plate ii, figs. 1, 2. MAGNIFICENT RIFLE BIRD.

1819. *Falcinellus magnificus* Vieillot, Nouv. Dict. d'Hist. Nat., nouv. ed., vol. xxviii, p. 167, pl. G.39, f. 3. May. New Guinea.

1812? *Paradisea furcata* Bullock, Companion to the London Museum, 15th ed., p. 46, 1813 (pref. Mch. 28), based on Black Bird of Paradise, plate, dated Apl. 1, 1812. (But not *Paradisea furcata* Latham, 1790.) New Guinea.

1821. *Epimach(us) filamentosus* Schinz, Das Thierreich (Cuvier), vol. i, p. 627, based on "Epimaque promefil Cuv.". Neuguinea ?

1826. *Epimachus splendidus* Stephens, Gen. Zool. (Shaw), vol. xiv, p. 77. Based on Cuv. Reg. Anim., vol. i, p. 408. No locality.

1861. *Paradisea magnifica major* Schlegel, Journ. für Ornith., 1861, p. 386, Sept. 20 (ex Müller). Triton Bay, western New Guinea. (Not *Paradisea major* Shaw, 1809.)

1869. *Ptiloris alberti* Wallace, Malay Archipelago, vol. ii, pp. 256/8, nomen nudum.

1870. *Ptilornis alberti* Gray, Handl. Gen. Sp. Birds B.M., vol. i, p. 105 (Feb. 2), in synonymy.

1871. *Ptiloris alberti* Elliot, Proc. Zool. Soc. (Lond.), 1871, p. 583, Oct. 1. Cape York, North Australia.

1876. *Ptiloris wilsonii* Ogden, Proc. Acad. Nat. Sci. Philad., 1875, p. 451, pl. 25, Jan. 11, 1876. New Guinea (based on an artefact).

1876. *Ptiloris superbus* Beccari, Ann. Mus. Civ. Genova, vol. vii, p. 713. Penslip only.

1882. *Ptilorhis intercedens* Sharpe, Journ. Linn. Soc. (Lond.), Zool., vol. xvi, p. 444, July 31. East Cape and Milne Bay, New Guinea (A. Goldie).

1917. *Craspedophora magnifica claudia* Mathews, Austral. Avian Rec., vol. iii, p. 72, July 21. Claudie River, North Queensland.

1922. *Craspedophora magnifica yorki* Mathews, Austral. Avian Rec., vol. v, p. 8, July 17. Cape York, North Queensland.

Figured by Gould, Birds Austr., Suppl., pl. 51 (pt. i), Mch. 15, 1851; Elliot, Mon. Paradis., pl. 23 (*magnificus*), pl. 24 (*alberti*), 1873; Gould, Birds New Guinea, vol. i, pl. 13 (pt. ix), Mch. 1, 1879; Sharpe, Mon. Paradis., vol. i, pl. 3 (pt. i), 1891; pl. 4 (pt. vii) (*alberti*), 1897; pl. 5 (pt. ii) (*intercedens*), 1893; Mathews, Birds Austr., vol. xii, p. 378, pl. 592, 1926; described, Rothschild, Paradis., p. 24/25, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 867, 1930; Mayr, List New Guinea Birds, p. 174, 1941.

Genus LOPHORINA Vieillot. SUPERB BIRDS.

1816. *Lophorina* Vieillot, Anal. nouv. Ornith, p. 35, Apl. 14. Haplotype "Le Superbe, Buff" = *Paradisea superba* Forster. Name also spelt *Lophorhina* Wagler, 1827 (Syst. Av., pt. i, *Paradisea* (pp. 99, 102)).

LOPHORINA SUPERBA Forster. Plate iii. SUPERB BIRD-OF-PARADISE.

1781. *Paradisea superba* Forster, Indische Zool. (Pennant), p. 40 (2nd ed., 1791, vern. only), based on Planch. Enlum., 632. = New Guinea (Arfak Mts.).

1783. *Paradisea atra* Boddaert, Tabl. Planch. Enlum., p. 38, Dec., based on Planch. Enlum., 632, Buff, v, p. 231. = New Guinea (Arfak Mts.).

1790. *Paradisea furcata* Latham, Index Ornith., vol. i, p. 196. No locality. Mus. Leverianum.

1885. *Lophorina superba minor* Ramsay, Abstr. Proc. Linn. Soc. New South Wales, p. v, May 27; Proc. Linn. Soc. N.S.W., vol. x, p. 242, July 31. Astrolabe Mountains, S.E. New Guinea.

1907. *Lophorina minor latipennis* Rothschild, Bull. Brit. Orn. Club, vol. xix, p. 92, June 29. Rawlinson Mts., German New Guinea.

1915. *Lophorhina superba feminina* Ogilvie-Grant, Ibis, 1915, Jubilee Suppl. 2, p. 27, December. Utakwa River, Nassau Range, South-West New Guinea.
1930. *Lophorina superba niedda* Mayr, Orn. Monatsb., vol. 38, p. 179, Nov. 6. Wondiwoi, Wandammen district, W. New Guinea (Mayr).
1930. *Lophorina superba connectens* Mayr, Orn. Monatsb., vol. 38, p. 180, Nov. 6. Dawong, Herzog Mts., N.E. New Guinea (Mayr).
1932. *Lophorina superba sphinx* Neumann, Orn. Monatsb., vol. 40, p. 121, July 9. Locality unknown. Female or young male described.
1932. *Lophorina superba lehunti* Rothschild, Ann. Mag. Nat. Hist., ser. 10, vol. 10, p. 126. Mekeo, South-East New Guinea.
1934. *Lophorina superba pseudoparotia* Stresemann, Orn. Monatsb., vol. 42, p. 144, Sept. 20. Hunsteinspitze. Middle Sepik, N. New Guinea (Burgers).
1948. *Lophorina superba addenda* ante.

Figured by Elliot, Mon. Paradis., pl. ii, 1873; Gould, Birds New Guinea, vol. i, pl. 18 (pt. vi), Feb., 1878; Finsch and Meyer, Zeitschr. f. ges. Ornith., 1885, pl. 17 (*minor*); Gould-Sharpe, Birds New Guinea, vol. i, pl. 19 (pt. xxiv), 1888 (*minor*); Sharpe, Mon. Parad., vol. ii, pl. 15 (pt. iv), 1895; id., vol. ii, pl. 16 (pt. v), 1895 (*minor*); described, Rothschild, Paradis., p. 19, p. 20 (*minor*), 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 884, 1930; Mayr, List New Guinea Birds, p. 173, 1941.

Genus PAROTIA Vieillot. SIX-PLUMED BIRDS.

1816. *Parotia* Vieillot, Anal. nouv. Ornith., p. 35, Apl. 14. Haplotype "Sifelet, Buff." = *Paradisea sefilata* Forster. Name also spelt *Parotica* Wagler, 1827 (Syst. Av., pt. 1, *Paradisea*, p. 99, note, error only).
1841. *Otostylis* Gloger, Gemein. Hand.-u.-Hilfsb. Naturg., pt. i, heft 5, p. 344 (Nov. ?). New name for *Parotia* only. Name also spelt *Otostylus* Gray, Handl. Gen. Sp. Birds, pt. ii, p. 16, 1870.

PAROTIA SEFILATA Forster. Plate iv, figs. 3, 4. SIX-PLUMED BIRD-OF-PARADISE.

1781. *Paradisea sefilata* Forster, Indische Zool. (Pennant), p. 40 (2nd ed., 1791, vernac. only), based on Planch. Enlum., 633. New Guinea, Arfak Mts.
1783. *Paradisea sexpennis* Boddaert, Tabl. Planch. Enlum., p. 39, December, based on Planch. Enlum, 633, Buff., v, p. 253. New Guinea.
1786. *Paradisaea penicillata* Scopoli, Del Faun. et Flor. Insub., pt. ii, p. 88, based on Sonnerat, Nov. Guin., p. 158, tab. 97. New Guinea.
1788. *Paradisea aurea* Gmelin, Syst. Nat., pt. i, p. 402, July 25, based on Sifelet. Buff., v, p. 253, pl. 633. New Guinea.
1790. *Paradisea sexsetacea* Latham, Index Ornith., vol. i, p. 196, on exactly same basis as preceding. Also spelt *setacea, sentacea.*

Figured by Elliot, Mon. Paradis., pl. 10, 1873; Gould, Birds New Guinea, vol. i, pl. 25 (pt. i), 1875; Sharpe, Mon. Paradis., vol. ii, pl. 12 (pt. v), 1895; described, Rothschild, Paradis., pt. 7, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 883, 1930; Mayr, List New Guinea Birds, p. 172, 1941.

PAROTIA LAWESI Ramsay. Plate iv, figs. 1, 2. LAWES' BIRD-OF-PARADISE.

1885. *Parotia lawesi* Ramsay, Abstr. Proc. Linn. Soc. N.S.W., p. 5, May 27; Proc. Linn. Soc. N.S.W., vol. x, p. 243, July 31. Astrolabe Mts. S.E. New Guinea.
1897. *Parotia helenae* De Vis, Ibis, 1897, p. 390, July. Neneba, 4,000 feet, north slope of Mt. Scratchley, British New Guinea.
1934. *Parotia lawesi fuscior* Greenway, Proc. New Eng. Zool. Club, vol. 14, p. 2. Mt. Misim, Morobe district, north-east coast of New Guinea.
1948. *Parotia lawesi exhibita* ante.

Figured by Finsch and Meyer, Zeitschr. f. ges. Ornith., 1885, pl. 16; Gould-Sharpe, Birds New Guinea, vol. i, pl. 26 (pt. xxiii), 1887; Sharpe, Mon. Paradis., vol. ii, pl. 13, pt. ii, 1891; described, Rothschild, Paradis., p. 18, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 883, 1930; Mayr, List New Guinea Birds, p. 173, 1941.

PAROTIA WAHNESI Rothschild. Plate v, figs. 1, 2. WAHNES'S BIRD-OF-PARADISE.

1906. *Parotia wahnesi* Rothschild, Two New Birds of Paradise, p. 2, Oct. 1. Rawlinson Mts., Huon Peninsula, N.E. New Guinea (C. Wahnes).

Figured by Rothschild, Ibis, 1911, pl. 6; listed by Mathews, Syst. Av. Australas., pt. ii, p. 884, 1930; Mayr, List New Guinea Birds, p. 173, 1941.

PAROTIA DUIVENBODEI Rothschild. Plate v, fig. 3. DUIVENBODE'S BIRD-OF-PARADISE.

1900. *Parotia duivenbodei* Rothschild, Bull. Brit. Orn. Club, vol. x, p. 100, May 31. Dutch New Guinea.

Figured by Rothschild, Ibis, 1911, pl. 5; listed by Mathews, Syst. Av. Australas., pt. ii, p. 884, 1930; Mayr, List New Guinea Birds ,p. 182, 1941 (as hybrid between *Parotia sefilata* and *Lophorina superba*).

PAROTIA CAROLAE Meyer. Pl. v, fig. 4; pl. xiii, fig. 4. CAROL BIRD-OF-PARADISE.

1894. *Parotia carolae* Meyer, Bull. Brit. Orn. Club, vol. iv, p. vi, Nov. 30. "Amberno River", supposed to be from Weyland Mts., Dutch New Guinea.

1897. *Parotia berlepschi* Kleinschmidt, Orn. Monatsb., vol. v, p. 46, Mch.; Journ. für Orn. 45 Jr., heft 2, p. 174, figs. in text, Apl., 1897. Locality unknown.

1910. *Parotia carolae meeki* Rothschild, Bull. Brit. Orn. Club, vol. xxvii, p. 35, Dec. 31. Letekwa (sic) River, 2,000-2,500 feet, S.W. New Guinea (A. S. Meek).

1934. *Parotia carolae chalcothorax* Stresemann, Orn. Monatsb., vol. 42, p. 145, Sept. 20. Doormanpad-bivak, Upper Mamberano, Dutch New Guinea (van Heurn).

1934. *Parotia carolae chrysenia* Stresemann, Orn. Monatsb., vol. 42, p. 147, Sept. 20. Lordberg, Sepik Mts., North New Guinea (Burgers).

Figured by Meyer, Abh. ber. Zool. Mus. Dresden, vol. v, no. 5, p. 8, pl. 2, 1895; Sharpe, Mon. Paradis., vol. ii, pl. 14, pt. vii), 1897; described, Rothschild, Paradis., p. 18, p. 19 (*berlepschi*), 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 884, 1930; Mayr, List New Guinea Birds, p. 172, 1941.

Genus SELEUCIDIS Lesson. TWELVEWIRED BIRD.

1834. *Seleucidis* Lesson, Hist. Nat. Paradis., pt. ii, Synops., p. 28, Sept. (fide Sherborn). Haplotype *Seleucidis acanthilis* = *Paradisea melanoleuca* Daudin. Name also spelt *Seleucides* Lesson, Hist. Nat. Paradis., p. 227, 1835.

1840. *Nematophora* Gray, List Genera Birds, 1st ed., p. 12, April. Orthotype *Paradisea alba* Blumenbach = *P. melanoleuca* Daudin.

SELEUCIDIS MELANOLEUCUS Daudin. Plate ii, figs. 3 and 4.
TWELVEWIRED BIRD-OF-PARADISE.

1800. *Paradisea melanoleuca* Daudin, Traite d'Ornith., pt. ii, p. 278, Mch. 4, based solely on Pennant, Ind. Zool. Wayghihu; may be error for Arfak Pen'a.

1809. *Paradisea nigricans* Shaw, Gen. Zool., vol. vii, pt. 2, p. 489, pls. 60, 61. New Guinea.

1811. *Paradisea violacea* Bechstein, Kurze Uebers. Vögel (Latham), p. 133, pl. 25, based on Vieillot, Suppl. hist. nat. Ois. Parad., p. 37, pl. 13. No locality.

1819. *Falcinellus resplendescens* Vieillot, Nouv. Dict. d'Hist. Nat., nouv. ed., vol. 28, p. 165, May. No locality, cites Ois. Dorés, pl. 13, Ois. par. Also spelt *resplendens* Lesson.
1834. *Seleucidis acanthilis* Lesson, Hist. Nat. Ois. Parad., pt. ii, Syn. p. 29 (pl. 35), Sept. New name only.
1853. *Seleucides alba* Reichenbach and later authors.
1870. *Epimachus candida* Gray, Handl. Gen. Sp. Birds, pt. i, p. 105, as of Forster, in synonymy.
1876. *Seleucides ignota* Salvadori, Ann. Mus. Civ. Nat. Genova, vol. ix, p. 191 (dated Dec.), as of "Forster, Zool. Ind., p. 31 et p. 35, var. *secunda*, 1781".
1911. *Seleucides ignotus auripennis* Schlüter, Falco, vol. vii, p. 2. Dallmanshafen (= Wewak), north coast New Guinea.

Figured by Elliot, Mon. Paradis., pl. 22, 1873; Gould, Birds New Guinea, vol. ii, pls. 14, 15 (pt. xii), 1881; Sharpe, Mon. Paradis., vol. i, pls. 9, 10 (pt. vii), 1897; described, Rothschild, Paradis., p. 28, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 869, 1930; Mayr, List New Guinea Birds, p. 175, 1941.

Genus HETEROPTILORHIS Sharpe.

1898. *Heteroptilorhis* Sharpe, Mon. Paradis., pt. viii (Introd., p. x), Oct. Orthotype *Craspedophora mantoui* Oustalet.

HETEROPTILORHIS MANTOUI Oustalet. Plate vi, fig. 4. MANTOU'S RIFLE BIRD.

1891. *Craspedophora mantoui* Oustalet, Le Naturaliste, vol. xiii, p. 260, November. North-West New Guinea.
1895. *Craspedophora bruyni* Büttikofer, Notes Leyden Mus., vol. xvi, p. 161, Mch. 15. Arfak Mts., North-West New Guinea (J. Bensbach).

Figured by Oustalet, Nouv. Arch. Mus. Paris, ser. 3, vol. iv, p. 218, pl. 5, 1892; Sharpe, Mon. Paradis., vol. i, pl. 6 (pt. vi), 1896; described, Rothschild, Paradis., p. 25, 1898; listed by Mathews, Syst. Av. Australas., pt. ii, p. 868, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Craspedophora magnifica* and *Seleucides ignotus*).

Genus PARYPHEPHORUS Meyer.

1890. *Paryphephorus* Meyer, Ibis, 1890, p. 420, footnote, Oct. Haplotype *Craspedophora duivenbodei* Meyer.

PARYPHEPHORUS DUIVENBODEI Meyer. Plate vi, fig. 3. DUIVENBODE'S RIFLE BIRD.

1890. *Craspedophora duivenbodei* Meyer, Ibis, 1890, p. 49, pl. 12, October. Mountains of North-West New Guinea.

Figured by Sharpe, Mon. Paradis., vol. i, pl. 7 (pt. viii), 1898; described by Rothschild, Paradis., p. 22, 1898; listed by Mathews, Syst. Av. Australas., pt. ii, p. 868, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Craspedophora magnifica* and *Lophorina superba*).

Genus JANTHOTHORAX Büttikofer.

1895. *Janthothorax* Büttikofer, Notes Leyden Mus., vol. xvi, p. 163, Mch. 15. Haplotype *Janthothorax bensbachi* Büttikofer.

JANTHOTHORAX BENSBACHI Büttikofer. Plate vi, fig. 2. BENSBACH'S RIFLE BIRD.

1895. *Janthothorax bensbachi* Büttikofer, Notes Leyden Mus., vol. xvi, p. 163, Mch. 15. Arfak Mts., North-West New Guinea.

Figured by Sharpe, Mon. Paradis., vol. i, pl. 8 (pt. vi), 1896; described, Rothschild, Paradis., p. 22, 1898; listed, Mathews, Syst. Av. Australas., pt. ii,

p. 869, 1930; Mayr, List of New Guinea Birds, p. 182, 1941 (as hybrid between *Craspedophora magnifica* and *Paradisaea* (*minor*)).

Genus QUESOPARENS.

QUESOPARENS MIRABILIS Reichenow. Plate vi, fig. 1. REICHENOW'S RIFLE BIRD.

1901. *Paradisea mirabilis* Reichenow, Orn. Monatsb., vol. ix, p. 185, December. Kaiser Wilhelmshafen (= Madang), North New Guinea.

Figured by Reichenow, Journ. für Orn., 1902, pl. 1; listed by Mathews, Syst. Av. Australas., pt. ii, p. 869, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Seleucides ignotus* and *Paradisaea* (*minor*)).

Genus LAMPROTHORAX Meyer.

1894. *Lamprothorax* Meyer, Abh. ber. K. Zool. Mus. Dresden, vol. v, no. 2, p. 3. Haplotype *Lamprothorax wilhelminae* Meyer.

LAMPROTHORAX WILHELMINAE Meyer. Plate xi, fig. 4. WILHELMINA'S RIFLE BIRD.

1894. *Lamprothorax wilhelminae* Meyer, Abh. ber. K. Zool. Mus. Dresden, vol. v, no. 2, p. 3, plate. Arfak Mts., North-West New Guinea.

Figured Sharpe, Mon. Paradis., vol. i, pl. 30 (pt. vi), 1896; described, Rothschild, Paradis., p. 21, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 875, 1930; Mayr, List of New Guinea Birds, p. 182, 1941 (as hybrid between *Diphyllodes magnificus* and *Lophorina superba*).

Genus PARADIGALLA Lesson. WATTLED BIRD-OF-PARADISE.

1835. *Paradigalla* Lesson, Hist. Nat. Ois. Paradis., p. 242. Haplotype *Paradigalla carunculata* Lesson.

1852. *Lobopsis* Reichenbach, Av. Syst. t. 72. Sketch of bill, tip of wing and legs only. Cited by Gray, Cat. Gen. Subgen. Birds, p. 65, 1855, as synonym of *Paradigalla*.

PARADIGALLA CARUNCULATA Lesson. Plate vii, figs. 1, 2. WATTLED BIRD-OF-PARADISE.

1835. *Paradigalla carunculata* Lesson, Hist. Nat. Ois. Paradis., p. 242. No locality.

1840. *Paradigalla carunculata* Lesson, Revue Zool. soc. Cuv., 1840, p. 1, Jan., no. Coll. Dr. Abeille at Bordeaux.

1841. *Astrapia caronculata* Eydoux and Souleyet, Voy. Bonité, Zool., vol. i, p. 8. New Guinea.

Figured by Eydoux and Souleyet, Voy. Bonité, Atlas, Zool. Ois., pl. 4, 1841; Elliot, Mon. Paradis., pl. 17, 1873; Gould, Birds New Guinea, vol. i, pl. 16 (pt. vii), 1878; Sharpe, Mon. Paradis., vol. ii, pl. 10 (pt. ii), 1893; described, Rothschild, Paradis., p. 16, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 881, 1930; Mayr, List of New Guinea Birds, p. 170, 1941.

PARADIGALLA BREVICAUDA Rothschild and Hartert. Plate vii, fig. 4.
SHORT-TAILED WATTLED BIRD-OF-PARADISE.

1911. *Paradigalla brevicauda* Rothschild and Hartert, Novit. Zool., vol. xviii, p. 159, Sept. 25. Mt. Goliath, Central Dutch New Guinea, 5,000 feet (A. S. Meek).

1913. *Paradigalla intermedia* Ogilvie-Grant, Bull. Brit. Orn. Club, vol. xxxi, p. 105, July 10. Utakwa River, South-West New Guinea.

Figured by Rothschild, Ibis, 1912, pl. 2; listed, Mathews, Syst. Av. Australas., pt. ii, p. 882, 1930; Mayr, List New Guinea Birds, p. 170, 1941.

Genus MACGREGORIA De Vis.

1897. *Macgregoria* De Vis, Ibis, 1897, p. 251, April. Haplotype *Macgregoria pulchra* De Vis.

1897. *Maria* "Sclater" as below, not *Maria* Bigot, 1859.

MACGREGORIA PULCHRA De Vis. Plate vii, fig. 3. MACGREGOR'S BIRD-OF-PARADISE.

1897. *Macgregoria pulchra* De Vis, Ibis, 1897, p. 251, pl. vii, April. Mt. Scratchley, South-East New Guinea, 12,000 feet.

1897. *Maria macgregoria* "Sclater", Ibis, 1897, p. 252, April (ex Giglioli, Bull. Soc. geogr. Ital., ser. 3, vol. x, fasc. 1, p. 26, 1897, ex Guilianetti MS. nom. nud.) in synonymy.

1939. *Macgregoria pulchra carolinae* Junge, Nova Guinea, n.s., vol. iii, p. 82. Oranje Mts. 3,800 M (over 12,500 feet), Dutch New Guinea.

Figured Sharpe, Mon. Paradis., vol. ii, pl. xi (pt. vii), 1897; described, Rothschild, Paradis., p. 16, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 883, 1930; Mayr, List New Guinea Birds, p. 169, 1941.

Subfamily ASTRAPIINAE. LONG-TAILED BIRDS-OF-PARADISE.

Genus ASTRAPIA Vieillot. TRUE LONG-TAILS.

1816. *Astrapia* Vieillot, Anal. nouv. Ornith., p. 36, Apl. 14. Haplotype *Paradisea nigra* Gmelin.

ASTRAPIA NIGRA Gmelin. Plate viii, figs. 3, 4. LONG-TAIL.

1788. *Paradisea nigra* Gmelin, Syst. Nat., vol. i, pt. i, p. 401, July 25, based on Lath. syn. i, 2, p. 478. "In. oc. Ind" = New Guinea, Arfak Mountains.

1790. *Paradisea gularis* Latham, Index Ornith., vol. i, p. 196. On exactly same basis.

Figured, Elliot, Mon. Paradis., pl. 9, 1873; Gould, Birds New Guinea, vol. i, pl. 17 (pt. viii), 1878; Sharpe, Mon. Paradis., vol. i, pl. 17 (pt. ii), 1893; described, Rothschild, Paradis., p. 32, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 871, 1930; Mayr, List New Guinea Birds, p. 171, 1941.

ASTRAPIA ROTHSCHILDI Foerster. Plate viii, figs. 1, 2.
ROTHSCHILD'S LONG-TAILED BIRD.

1906. *Astrapia rothschildi* Foerster, Two New Birds of Paradise, p. 2, Oct. 1. Rawlinson Mts., Huon Peninsula, North-East New Guinea (C. Wahnes).

1918. *Astrapia alboundata* Reichenow, Journ. für Ornith., vol. 66, p. 244. "Probably the eastern part of Kaiser Wilhelm's Land" = Huon Peninsula, N.E. New Guinea.

Figured by Rothschild, Nov. Zool., vol. xviii, pl. viii, 1912; listed by Mathews, Syst. Av. Australas., pt. ii, p. 872, 1930; Mayr, List New Guinea Birds, p. 172, 1941.

Genus CALASTRAPIA Sharpe.

1898. *Calastrapia* Sharpe, Mon. Paradis., Introd., p. xiii (pt. viii), Oct. Orthotype *Astrapia splendidissima* Rothschild.

CALASTRAPIA SPLENDIDISSIMA Rothschild. Plate x, figs. 3, 4.
THE MOST SPLENDID LONG-TAIL.

1895. *Astrapia splendidissima* Rothschild, Nov. Zool., vol. ii, p. 59, pl. 5, July 3. "Charles Louis Mountains" = Weyland Mts., Dutch New Guinea.

1936. *Astrapia splendidissima helios* Mayr, Amer. Mus. Novit., no. 869, p. 3, July 2. Mt. Goliath, Oranje Range, Central New Guinea (A. S. Meek).

Figured, Sharpe, Mon. Paradis., vol. i, pl. 18 (pt. viii), 1898; described, Rothschild, Paradis., p. 32, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 872, 1930; Mayr, List New Guinea Birds, p. 171, 1941.

Genus Astrarchia Finsch and Meyer.

1885. *Astrarchia* Finsch and Meyer, Zeitsch. ges. Orn., vol. 2, p. 378, ex Meyer MS. Haplotype *Astrarchia stephaniae* Finsch and Meyer.

Astrarchia stephaniae Finsch and Meyer. Plate ix, figs. 1, 2.
Stephanie's Bird of Paradise.

1885. *Astrarchia stephaniae* Finsch and Meyer, Zeitsch. ges. Orn., vol. 2, p. 378, pl. 18, ex Finsch MS. Astrolabe Mts., S.E. New Guinea.
1922. *Astrarchia stephaniae feminina* Neumann, Verh. Orn. ges. Bayern, vol. 15, p. 236. Schraderberg, Sepik R., N. New Guinea.
1931. *Astrapia stephaniae ducalis* Mayr, Mitt. zool. Mus. Berlin, vol. 17, p. 711, December. Dawong, Herzog Mts., North-East New Guinea (Mayr).

Figured, Sharpe, Mon. Paradis., vol. i, pl. 19 (pt. iii), 1894; described, Rothschild, Paradis., p. 33, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 872, 1930; Mayr, List New Guinea Birds, p. 172, 1941.

Astrarchia barnesi. Plate x, fig. 1. Barnes' Long-tailed Bird.

Genus Taeniaparadisea Kinghorn.

1939. *Taeniaparadisea* Kinghorn, Austr. Zool., vol. ix, p. 295, December 12. Haplotype *T. macnicolli* Kinghorn = *Astrapia mayeri* Stonor.

Taeniaparadisea mayeri Stonor. Plate ix, figs. 3, 4; Plate xiii, figs. 2, 3.
Ribbon-Tail.

1939. *Astrapia mayeri* Stonor, Bull. Brit. Orn. Club, vol. 59, p. 57, February, based on tail feathers only. Central New Guinea.
1939. *Taeniaparadisea macnicolli* Kinghorn, Aust. Zool., vol. ix, p. 295, pl. xxv, Dec. 12. Hagen-Sepik district, 8,000–10,000 ft., Central New Guinea.

Listed, Mayr, List New Guinea Birds, p. 172, 1941, in error under *feminina*

Genus Astrapimachus Mayr.

1941. *Astrapimachus* Mayr, List New Guinea Birds, p. 181, post Feb. Haplotype *Epimachus ellioti* Elliot.

Astrapimachus ellioti Elliot. Plate xi, fig. 2. Elliot's Bird of Paradise.

1873. *Epimachus ellioti* Elliot, Mon. Parad., pl. 20, ex Ward MS. New Guinea.
1874. *Epimachus ellioti* Ward, Proc. Zool. Soc. (Lond.), 1873, p. 742, April, 1874. New Guinea via Singapore.

Figured, Gould, Birds New Guinea, vol. i, pl. 8 (pt. xi), 1880; Sharpe, Mon. Paradis., vol. i, pl. 16 (pt. vi), 1896; described, Rothschild, Paradis., p. 29, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 871, 1930; Mayr, List New Guinea Birds, p. 181, 1941 (as hybrid between *Astrapia nigra* and *Epimachus fastosus*).

Astrapimachus astrapioides Rothschild. Plate x, fig. 2.
Green-breasted Sickle Bill.

1897. *Epimachus astrapioides* Rothschild, Bull. Brit. Orn. Club, vol. vii, p. xxii, Dec. 29. Dutch New Guinea.

Figured, Rothschild, Nov. Zool., vol. xviii, pl. vii, 1912; described, Rothschild, Paradis., p. 30, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 371, 1930; Mayr, List New Guinea Birds, p. 181, 1941 (as hybrid between *Astrapia nigra* and *Epimachus fastosus*).

Genus Loborhamphus Rothschild.

1901. *Loborhamphus* Rothschild, Bull. Brit. Orn. Club, vol. xii, p. 34, Dec. 30. Haplotype *Loborhamphus nobilis* Rothschild.

Loborhamphus nobilis Rothschild. Plate xi, fig. 3. Noble Lobe-Bill.

1901. *Loborhamphus nobilis* Rothschild, Bull. Brit. Orn. Club, vol. xii, p. 34, Dec. 30. Dutch New Guinea.

Figured, Rothschild, Nov. Zool., vol. x, pl. 1, 1903; listed, Mathews, Syst. Av. Australas., pt. ii, p. 875, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Lophorina superba* and *Paradigalla carunculata*).

Genus Loboptiloris.

Loboptiloris ptilorhis Sharpe. Plate xiv, fig. 4. Sharpe's Lobe-Bill.

1908. *Loborhamphus ptilorhis* Sharpe, Bull. Brit. Orn. Club, vol. xxi, p. 67, Mch. 30. Dutch New Guinea.

Listed, Mathews, Syst. Av. Australas., pt. ii, p. 876, 1930; Mayr, List New Guinea Birds, p. 181, 1941 (as hybrid between *Paradigalla carunculata* and *Parotia sefilata*).

Genus Pseudastrapia Rothschild.

1907. *Pseudastrapia* Rothschild, Bull. Brit. Orn. Club, vol. xxi, p. 25, Nov. 29. Haplotype *Pseudastrapia lobata* Rothschild.

Pseudastrapia lobata Rothschild. Pl. xiv, fig. 1. False-lobed Long Tail.

1907. *Pseudastrapia lobata* Rothschild, Bull. Brit. Orn. Club, vol. xxi, p. 25, Nov. 29. Dutch New Guinea.

Listed, Mathews, Syst. Av. Australas., pt. ii, p. 871, 1930 (in synonymy); Mayr, List New Guinea Birds, p. 181, 1941 (as hybrid between *Epimachus fastosus* and *Paradigalla carunculata*).

Subfamily Epimachinae. Sickle Bills.

Genus Epimachus Cuvier.

1816. *Epimachus* Cuvier, Règne Animal, vol. i, p. 407, "1817" = Dec. 4, 1816. Logotype; Gray, 1840, p. 12, *Upupa magna* Gmelin = *Promerops fastuosus* Hermann.

1816. *Falcinellus* Vieillot, Anal. nouv. Orn., p. 47, Apl. 14. Haplotype "Promerops, Buff." = *Promerops fastuosus* Hermann. (Not *Falcinellus* Illiger, 1811.)

1834. *Cinnamolegus* Lesson, Hist. Nat. Ois. Paradis., pt. ii, p. 31, September. Haplotype *Cinnamolegus papuanus* Lesson = *Promerops fastuosus* Hermann.

Epimachus fastuosus Hermann. Pl. xii, fig. 3; Pl. xiii, fig. 1.
Greater Sickle Bill.

1783. *Promerops fastuosus* Hermann, Tabl. Affin. Anim., p. 194, ante Dec., based on Buff. iv, p. 472 (Planch. Enlum., 638, 639). New Guinea = Arfak Mts.

1783. *Upupa striata* Boddaert, Tabl. Planch. Enlum., p. 39, December, based on Pl(anch.) Enlum, 638, Buff., xii, p. 159. New Guinea.

1783. *Upupa speccosa* Boddaert, Tabl. Planch. Enlum., p. 39, December, based on Pl(anch.) Enlum, 639, Buff., xii, p. 161. New Guinea.

1786. *Merops bruneus* Scopoli, Del Faun. et Flor. Insubr., pt. ii, p. 90, based on Sonnerat, Nov. Guin., p. 164 (tab. 100). New Guinea.

1786. *Merops maximus* Scopoli, Del Faun. et Flor. Insubr., pt. ii, p. 90, based on Sonnerat, Nov. Guinea, p. 166 (tab. 101). New Guinea.

1788. *Upupa fusca* Gmelin, Syst. Nat., pt. i, p. 468, July 25, based on Pl(anch.) Enlum., 638 (i), Sonnerat, p. 164, t. 100. New Guinea.
1788. *Upupa magna* Gmelin, Syst. Nat., pt. i, p. 468, July 25, based on Pl(anch.) Enlum., 639 (i), Sonnerat, p. 166, t. 101. New Guinea.
1790. *Upupa papuensis* Latham, Index Ornith., vol. i, p. 279 (ante Dec. 9), based on same data as *Upupa fusca* Gmelin.
1790. *Upupa superba* Latham, Index Ornith., vol. i, p. 279 (ante Dec. 9), based on same data as *Upupa magna* Gmelin.
1819. *Falcinellus fuscus* Vieillot, Nouv. Dict. d'Hist. Nat., nouv. ed., vol. xxviii, p. 165, May, on *Upupa papuensis* Latham, Ois. Dores., pl. 7, Promerops. Labillardière at Waygiou.
1834. *Cinnamolegus papuanus* Lesson, Hist. Nat. Ois. Paradis., pt. ii, p. 31, Sept., p. 233, pls. 39–40, 1835. Nouvelle Guinée. Ile de Waigiou (La Billardière). Misspelt *papuensis* Bonaparte, Consp. Gen. Av., vol. i, p. 411, Feb., 1851, error only.
1911. *Falcinellus striatus atratus* Rothschild and Hartert, Nov. Zool., vol. 18, p. 160, Sept. 25. Mt. Goliath, 5,000 ft., Central Dutch New Guinea (A. S. Meek).
1930. *Epimachus fastosus stresemanni* Hartert, Nov. Zool., vol. 36, p. 34, Nov. 15. Schraderberg, Sepik Mts., North New Guinea (Bürgers).

Figured, Elliot, Mon. Paradis., pl. 19, 1873; Gould, Birds New Guinea, vol. i, pl. 9, pt. vii, 1878; Sharpe, Mon. Paradis., vol. i, pl. 14 (pt. iii), 1894; described, Rothschild, Paradis., p. 30, 1898; listed by Mathews, Syst. Av. Australas., pt. ii, p. 870, 1930; Mayr, List New Guinea Birds, p. 170, 1941.

Epimachus meyeri Finsch and Meyer. Pl. xii, figs. 1, 2. Meyer's Sickle Bill.

1885. *Epimachus meyeri* Finsch and Meyer, Zeitschr. ges. Ornith., vol. ii, p. 380, ex Finsch MS. Astrolabe Mts., South-East New Guinea (C. Hunstein).
1887. *Epimachus macleayanae* Ramsay, Abstr. Proc. Linn. Soc. New South Wales, for May 25, p. iv; Proc. Linn. Soc. N.S.W., vol. xii, p. 239, Aug. 31. Astrolabe Mts., New Guinea (Goldie). Also spelt *E. macleayae* Meyer, Journ. für Orn., 1889, p. 324, July no. Correction only.
1915. *Falcinellus meyeri albicans* Oort, Zool. Mededeel. Mus. Nat. Hist. Leiden, vol. i, p. 228, Dec. 22. Treub Mts., 7,000 ft., Dutch New Guinea (G. Verstega).

Figured, Sharpe, Mon. Paradis., vol. i, p. 15, pt. i, 1891; described, Rothschild, Paradis., p. 31, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 871, 1930; Mayr, List New Guinea Birds, p. 171, 1941.

Genus Drepanornis Sclater.

1873. *Drepanornis* Sclater, Nature, vol. viii, p. 305, Aug. 14; Proc. Zool. Soc. (Lond.), 1873, pp. 558/560, Nov. Haplotype *Drepanornis albertisi* Sclater.
1873. *Drepanornis* Sclater, Nature, vol. viii, p. 192, July 3, *nomen nudum*; new name for
1873. *Drepanephorus* Sclater, Nature, vol. viii, p. 151, June, *nomen nudum*. Not *Drepanephorus* Egerton, 1872.

Drepanornis albertisi Sclater. Plate xv, figs. 1, 2. Red Sickle Bill.

1873. *Drepanornis albertisi* Sclater, Nature, vol. viii, p. 305, fig. on p. 306, Aug. 14; id., ib., Proc. Zool. Soc. (London), 1873, p. 560, pl. 47, November. Atam, Arfak Mts, 3,000 feet, North-West New Guinea (Albertis).
1874. *Epimachus wilhelminae* Meyer, Nat. Tijdschr. Ned. Indie, ser. 7, vol. 3, p. 415, after Dec., 1873; Journ. für Orn., 1873, p. 405, Nov. no. (publd. Mch., 1874). Arfak Mts., 3,000–6,000 feet, North-West New Guinea.

1874. *Epimachus veithii* Sclater, Ibis, 1874, p. 187, Apl., ex Rosenberg MS., as a synonym of *Drepanornis albertisi*.

1874. *Epimachus vethi* Rosenberg, Reist. Geelvink., p. 116, pl. xviii (pref. July 15). North-West New Guinea = Hattam (footnote, p. 117 = *D. albertisii*).

1884. *Drepanornis albertisi cervinicauda* Sclater, Proc. Zool. Soc. (Lond.), 1883, p. 578, Apl. 1884. Port Moresby, South-East New Guinea (Goldie).

1893. *Drepanornis geisleri* Meyer, Abh. Ber. K. Zool. Mus. Dresden, bd. iv, 1892–3, no. 3, p. 15. Mt. Sattelberg, North-East New Guinea, 900 M. (Geisler).

1936. *Drepanornis albertisi inversa* Hartert, Paludan, Rothschild and Stresemann, Mitt. zool. Mus. Berlin, vol. xxi, p. 188, Sept. 1. Kunupi, 1,200–1,300 M., Weyland Mts., W. New Guinea.

Figured, Elliot, Mon. Parad., pl. 21, 1873; Gould, Birds New Guinea, vol. i, pl. ii (pt. i), 1875; Albertis, New Guinea, pl., 1880; Finsch and Meyer, Zeitschr. ges. Orn., 1885, pl. 19; Gould-Sharpe, Birds New Guinea, vol. i, pl. 10 (pt. xxx) (*cervinicauda*), 1885; Sharpe, Mon. Paradis., vol. i, pl. 12 (pts. iv and v), 1895; described, Rothschild, Paradis., p. 27, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 869, 1930; Mayr, List New Guinea Birds, p. 170, 1941.

Genus DREPANANAX Sharpe.

1894. *Drepananax* Sharpe, Bull. Brit. Orn. Club, vol. iv, p. 15; Dec. 29. Orthotype *Drepanornis bruyni* Oustalet.

DREPANANAX BRUYNI Oustalet. Plate xv, figs. 3, 4. WHITEBILLED SICKLE BIRD.

1880. *Drepanornis bruyni* Oustalet, Ann. Sci. Nat. Paris, ser. 6, vol. 9, art. 5, p. 28 (170). North coast of New Guinea, 136° 30′–137° (A. A. Bruijn).

Figured, Gould-Sharpe, Birds New Guinea, vol. i, pl. 12 (pt. xxi), 1886; Oustalet, Nouv. Arch. Mus. Paris, ser. 3, vol. 5, pl. 6, 1893; Sharpe, Mon. Paradis., vol. i, pl. 13 (pt. iv), 1895; described, Rothschild, Paradis., p. 28, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 870, 1930; Mayr, List New Guinea Birds, p. 170, 1941.

Subfamily CICINNURINAE. KING BIRDS.

Genus CICINNURUS Vieillot.

1816. *Cicinnurus* Vieillot, Anal. nouv. Ornith., p. 35, Apl. 14. Haplotype "Manucode Buff." = *Paradisaea regia* Linné. Also spelt *Cinnurus* Drapiez, 1828 (Dict. Class d'Hist. Nat., vol. xxx, p. 46); *Cincinnurus* Cuvier, 1829 (Règne Animal, 2nd ed., vol. i, p. 426); *Circinurus* Gloger, 1841 (Gemein. Hand.-u.-Hilfsb. Naturg., pt. i, p. 344); *Cicinnura* Bonaparte, 1851 (Consp. Gen. Av., vol. i, p. 413).

CICINNURUS REGIUS Linné. Plate xiv, figs. 3, 4, 5. KING BIRD-OF-PARADISE.

1758. *Paradisaea regia* Linné, Syst. Nat., 10th ed., p. 110, Jan., based on Mus. Av. Fr., i, p. 15, and many others. In India orientali = Aru Islands.

1786. *Paradisaea rex* Scopoli, Del Faun. et Flor. Insubr., pt. ii, p. 88, based on Sonnerat, Nov. Guin., p. 156, tab. 95. New Guinea.

1834. *Cicinnurus spinturnix* Lesson, Hist. Nat. Ois. Paradis., pt. i, Syn., p. 14, July. A substitute name only.

1896. *Cicinnurus regius coccineifrons* Rothschild and Hartert, Nov. Zool., vol. iii, p. 10, ex Rothschild MS., Mch. 14. Jobi I. = Japen.

1915. *Cicinnurus regius claudii* Ogilvie-Grant, Ibis, 1915, Jubilee Suppl. 2, p. 16, text-figs. 1, 2, December. Mimika River, South-West New Guinea.

1922. *Cicinnurus regius gymnorhynchus* Stresemann, Journ. für Orn., vol. 70, p. 405. Near Finschhafen, North-Eastern New Guinea.

1922. *Cicinnurus regius similis*, id., ib. Stephansort, Astrolabe Bay, North-Eastern New Guinea.

1922. *Cicinnurus regius cryptorhynchus*, id., ib., Tana, lower Mamberano River, Northern New Guinea.

1922. *Cicinnurus regius similis* Neumann, Verh. Orn. ges. Bayern, vol. x, p. 236. Stephansort, North-Eastern New Guinea.

Figured, Elliot, Mon. Paradis., pl. 16, 1873; Gould, Birds New Guinea, vol. i, pl. 24 (pt. iii), 1876; Sharpe, Mon. Paradis., vol. i, pl. 31 (pt. i), 1891; described, Rothschild, Paradis., p. 35, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 876, 1930; Mayr, List New Guinea Birds, p. 176, 1941.

CICINNURUS LYOGYRUS Currie. Plate xiv, fig. 3. LONELY LITTLE KING.

1900. *Cicinnurus lyogyrus* Currie, Proc. U.S. Nat. Mus., vol. xxii, p. 497, pl., July 7. New Guinea.

1907. *Cicinnurus goodfellowi* Ogilvie-Grant, Bull. Brit. Orn. Club, vol. xix, p. 39, Jan. 26. Cyclops Mts., 3,000 ft., North Dutch New Guinea (W. Goodfellow).

Listed, Mathews, Syst. Av. Australas., pt. ii, p. 877, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Cicinnurus regius* and *Diphyllodes magnificus*).

Genus DIPHYLLODES Lesson.

1834. *Diphyllodes* Lesson, Hist. Nat. Ois. Parad., pt. i, Syn., p. 16, July. Haplotype *Paradisea magnifica* Forster.

1842. *Cricocercus* Gloger, Gemelin. Hand.-u.-Hilfsb. Naturg., pt. i, p. 345 (Nov. ?). Haplotype *Paradisea magnifica* Forster. Also spelt *Oriocercus* Giebel, *Oricocercus* Gray, 1870 (Handl. Gen. Sp. Birds, pt. ii, p. 16).

DIPHYLLODES MAGNIFICA Forster. Plate xiv, figs. 1 and 2.
MAGNIFICENT BIRD OF PARADISE.

1781. *Paradisea magnifica* Forster, Zool. Indische (Pennant), p. 40, based on Planch. Enlum., 631. New Guinea, Arfak Mts.

1783. *Paradisea speccosa* Boddaert, Tabl. Planch. Enlum, p. 38, December, based on Pl(anch.) Enlum., 631. New Guinea.

1834. *Diphyllodes seleucides* Lesson, Hist. Nat. Ois. Parad., pt. i, p. 16, July; id., p. 191, pl. 19, 20, 1835; new name only.

1873. *Diphyllodes speciosa* var. *chrysoptera* Elliot, Mon. Paradis., pl. 13, ex Gould MS. (Gould's specimen described). Locality unknown = Jobi I. (Japen), New Guinea.

1882. *Diphyllodes chrysogaster* Sharpe, Journ. Linn. Soc. (Lond.), Zool., vol. xvi, p. 443, July 31 (from Taburi, East Cape), but lapsus only for preceding.

1885. *Diphyllodes jobiensis* Finsch and Meyer, Zeitschr. für ges. Ornith., vol. 2, p. 388 (ex Meyer MS.). Jobi I. = Japen I., North-West New Guinea.

1885. *Diphyllodes hunsteini* Finsch and Meyer, Zeitschr. ges. Ornith., vol. 2, p. 389, pl. 21 (ex Meyer MS.). Hufeisengebirge, South-East New Guinea (C. Hunstein).

1892. *Diphyllodes chrysoptera septentrionalis* Meyer, Journ. für Orn., vol. 40, p. 260, July no. Bubui R., Huon Gulf, North-East New Guinea.

1896. *Diphyllodes xanthoptera* Salvadori, Bull. Brit. Orn. Club, vol. iv, p. xxii Feb. 29. No locality; Ann. Mus. Civ. Genova, ser. 2, vol. 16, p. 110 (dated Mch. 10), Moroka, South-East New Guinea.

1915. *Diphyllodes rothschildi* Ogilvie-Grant, Ibis, 1915, Jubilee Suppl., 2, p. 24, December. I. of Salawati, Western New Guinea.

1930. *Diphyllodes magnificus intermedius* Hartert, Nov. Zool., vol. 36, p. 36, November 15. Snow Mountains, 2,500 feet, Dutch New Guinea (A. S. Meek).

Figured, Elliot, Mon. Parad., pl. 12, pl. 13 (var. *chrysoptera*) 1873; Gould, Birds of New Guinea, vol. i, pl. 22 (*speciosa*), pl. 23 (*chrysoptera*) (pt. ii), 1876; Sharpe, Mon. Paradis., vol. i, pl. 33 (*magnifica*), pt. vi, 1896; pl. 34 (*seleucides*), pt. vi, 1896; pl. 35 (*chrysoptera*), pt. iv, 1895; pl. 36 (*hunsteini*), pt. v, 1895; described, Rothschild, Paradis., p. 36, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 877, 1930; Mayr, List New Guinea Birds, p. 175, 1941.

Genus RHIPIDORNIS Salvadori.

1876. *Rhipidornis* Salvadori, Ann. Mus. Civ. Genova, vol. ix, p. 192, footnote (dated Dec. 3). Orthotype *Diphyllodes gulielmi III* Meyer.

RHIPIDORNIS GULIELMI III Meyer. Plate xix, fig. 5. EXQUISITE LITTLE KING.

1875. *Diphyllodes gulielmi III* Meyer, Zool. Gart., 1875, p. 29, Jan., ex Musschenbrock MS.; Nature, vol. xi, p. 208, Jan. 14, 1875; Proc. Zool. Soc. (Lond.), 1875, p. 31, June 1. Eastern Waigiou.

Figured, Meyer, Mitth. Zool. Mus. Dresden, vol. i, pl. i, 1875; Gould, Birds New Guinea, vol. i, pl. 21 (pt. ii), 1876; Sharpe, Mon. Paradis, vol. i, pl. 32 (pt. ii), 1893; described, Rothschild, Paradis, p. 36, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 877, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Cicinnurus regius* and *Diphyllodes magnificus*).

Genus SCHLEGELIA Bernstein.

1864. *Schlegelia* Bernstein, Nat. Tijdschr. Nederl. Indie, vol. xxvii, p. 79 (includes Sept. meeting); Nederl. Tijdschr. Dierk, 1864, p. 320. Haplotype *Schlegelia calva* Bernstein.

SCHLEGELIA WILSONII Cassin. Plate xvii, figs. 3, 4. BARE-HEADED LITTLE KING.

1850. *Paradisea wilsonii* Cassin, Proc. Acad. Nat. Sci. Philad., 1850, p. 67 (read Aug. 27). New Guinea?

[1850. *Lophorina respublica* Bonaparte, Comptes Rendus Acad. Sci. Paris, vol. xxx, p. 131, Feb. 11/18; descr. indeterminable; *Diphyllodes respublica*, id., ib., p. 291, Mch. 11/18, and Consp. Gen. Av., vol. i, p. 413, Feb., 1851, descr. still indeterminable.]

1864. *Schlegelia calva* Bernstein, Nat. Tijdschr. Nederl. Indie, vol. xxvii, p. 79, after Sept. Waigiou.

Figured, Cassin, Proc. Acad. Nat. Sci. Philad., 1852, pl. 15; Bernstein, Nederl. Tijdschr. Dierk, 1865, Vogeld, pl. 7; Elliot, Mon. Parad., pl. 14, 1873; Gould, Birds New Guinea, vol. i, p. 20, pt. iii, 1876; Sharpe, Mon. Paradis., vol. i, p. 37 (pt. iii), 1894; described, Rothschild, Paradis., p. 33, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 878, 1930; Mayr, List New Guinea Birds, p. 176, 1941.

Subfamily PARADISEINAE. TRUE BIRDS OF PARADISE.

Genus PARADISEA Linné.

1758. *Paradisea* Linné, Syst. Nat., 10th ed., p. 83, Jan. 1. Tautotype *Paradisaea apoda* Linné. Also spelt *Paradisaea* Linné, ib., p. 110, error only, corrected in later editions.

1760. *Manucodiata* Brisson, Ornith., vol. i, p. 30; vol. ii, p. 130. Tautotype *Paradisaea apoda* Linné.

1829. *Samalia* Cuvier, Règne Animal, 2nd ed., vol. i, p. 426, footnote (as of Vieillot). Haplotype *Paradisaea apoda* Linné.

PARADISEA APODA Linné. Plate xvii, figs. 1, 2. GREATER BIRD-OF-PARADISE.

1758. *Paradisaea apoda* Linné, Syst. Nat., 10th ed., p. 110, Jan., based on It. Wgoth., 139, Mus. Av. Fr., i, p. 15, etc. "In India" = Aru Islands.

1809. *Paradisea major* Shaw, Gen. Zool., vol. vii, pt. ii, p. 480, pl. (dated Sept. 1, 1808). New Guinea ± Aru Is.

1826. *Paradisea smaragdina* Dumont, Dict. Sci. Nat. (Levrault), vol. xxxvii, p. 501, May 31. New name only for *apoda.*

1835. *Paradisea magia* Partington, Brit. Cycl. Nat. Hist., vol. i, p. 487, error only for *major.*

1847. *Paradisea domicellarum* Gistel and Bromme, Handb. Naturg., p. 286, pl. 9, fig. 9; new name only. New Guinea.

1858. *Paradisea apoda* var. *wallaciana* Gray, Proc. Zool. Soc. (Lond.), 1858, p. 181, July 13. Aru Islands (Wallace).

Figured, Elliot, Mon. Paradis., pl. 2, 1873; Gould, Birds New Guinea, vol. i, pl. 30 (pt. ix), 1879; Sharpe, Mon. Paradis., vol. i, pl. 20 (pt. i), 1891; described, Rothschild, Paradis., p. 39, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 873, 1930; Mayr, List New Guinea Birds, p. 177, 1941.

PARADISEA NOVAEGUINEAE D'Albertis and Salvadori. Plate xvi, fig. 3.
THE FLY RIVER BIRD OF PARADISE.

1879. *Paradisea apoda* var. *novaeguineae* D'Albertis and Salvadori, Ann. Mus. Civ. Genova, vol. xiv, p. 96. Fly River, South New Guinea.

Described, Rothschild, Paradis, p. 39, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 873, 1930; Mayr, List New Guinea Birds, p. 177, 1941.

PARADISEA AUGUSTAEVICTORIAE Cabanis. Plate xviii, fig. 3. THE AUGUSTA VICTORIA.

1888. *Paradisea augustaevictoriae* Cabanis, Journ. für Orn., 1888, p. 119, Jan. no. Kaiser Wilhelm's Land, North-East New Guinea.

1894. *Paradisea intermedia* De Vis, Ann. Rep. Brit. New Guinea, 1893–4, App. EE, p. 105, Nov. Kumusi River, North-East New Guinea.

1906. *Paradisea granti* North, Vict. Naturalist, vol. xxii, p. 147, plate, Jan. 11. German New Guinea?

1913. *Paradisea raggiana sororia* Menegaux, Rev. Franc. d'Orn., vol. iii, p. 50, Apl. 7. New Guinea (ex Mantou).

1921. *Paradisea mixta* Rothschild, Bull. Brit. Orn. Club, vol. 41, p. 127, May 26. Habitat unknown.

1921. *Paradisea apoda subintermedia* Rothschild, Bull. Brit. Orn. Club, vol. 41, p. 138, July 5. Inland from Huon Gulf, North-East New Guinea.

Figured, Cabanis, Journ. für Orn., vol. 37, pl. 2, 1889; Sharpe, Mon. Paradis., vol. i, pl. 22, pt. iii, 1894 (*augustaevictoriae*); id., pl. 23 (pt. viii), 1898 (*intermedia*); described, Rothschild, Paradis, p. 41, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 873, 1930; Mayr, List New Guinea Birds, p. 177, 1941; *mixta*, p. 183 (as hybrid between *Paradisaea minor finschi* and *Paradisaea apoda augustaevictoriae*).

PARADISEA RAGGIANA Sclater. Plate xviii, figs. 2, 4. RED-PLUMED BIRD-OF-PARADISE.

1873. *Paradisea raggiana* Sclater, Nature, vol. viii, p. 306, Aug. 14. Orangeri Bay, New Guinea; Proc. Zool. Soc. (Lond.), 1873, p. 559, footnote, November.

1923. *Paradisea apoda luptoni* Lowe, Bull. Brit. Orn. Club, vol. 43, p. 110, Mch. 5. No exact locality (perhaps shipped from Merauke, South New Guinea).

1935. *Paradisea apoda salvadorii* Mayr and Rand, Amer. Mus. Novit., no. 814, p. 11, August 1. Vanumai, Central Division, Papua (H. Hamlin).

Figured, Elliot, Mon. Paradis., pl. 13, 1873; Gould, Birds New Guinea, vol. i, pl. 32 (pt. iv), 1877; Sharpe, Mon. Paradis., vol. i, pl. 21 (pt. vi), 1896; described, Rothschild, Paradis, p. 41, 1896; listed, Mathews, Syst. Av. Australas., pt. ii, p. 873, 1930; Mayr, List New Guinea Birds, p. 177, 1941 (as *Paradisaea apoda salvadorii*).

PARADISEA DECORA Salvin and Godman. Plate xx, figs. 1, 2.
GOLDIE'S BIRD-OF-PARADISE.

1883. *Paradisea decora* Salvin and Godman, Ibis, 1883, p. 131, Jan.; id., p. 202, pl. 8, Apl. Fergusson Island, D'Entrecasteaux Islands.

1883. *Paradisea susannae* Ramsay, Abstr. Proc. Linn. Soc. New South Wales, Jan. 31, p. ii; Proc. Linn. Soc. N.S.W., vol. 8, p. 21, June 19. D'Entrecasteaux Islands, east of New Guinea (Rolles).

Figured, Gould-Sharpe, Birds of New Guinea, vol. i, pl. 27 (pt. xx), 1885; Sharpe, Mon. Parad., vol. i, pl. 24 (pt. viii), 1898; described, Rothschild, Paradis., p. 42, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 874, 1930; Mayr, List New Guinea Birds, p. 178, 1941.

PARADISEA MINOR Shaw. Plate xix, figs. 1, 2, 3. LESSER BIRD-OF-PARADISE.

1809. *Paradisea minor* Shaw, Gen. Zool., vol. vii, pt. 2, p. 486, pl. (dated Sept., 1808). New Guinea = Dorey, North-West New Guinea.

1811. *Paradisea papuana* Bechstein, Kurze Uebers. Vogel (Latham), p. 131, pl. 22, based on Audebart, l.c., p. 15, pl. i. I. Papua and Misoal. Also spelt *papuensis* Lesson, Manuel Orn., vol. i, p. 392, 1828.

1835. *Paradisea micra* Partington, Brit. Cycl. Nat. Hist., vol. i, p. 488, error only for *minor*.

1860. *Paradisea bartletti* Goodwin, Proc. Zool. Soc. (Lond.), 1860, p. 244, Nov. New Guinea.

1883. *Paradisea minor* var. *albescens* Musschenbroek, Dagboek van Bernstein, p. 187, Cf. Meyer, Ibis, 1890, p. 421.

1885. *Paradisea finschi* Finsch and Meyer, Zeitsch. ges. Orn., vol. 2, p. 383 (ex Meyer MS.). Karan, N.W. New Guinea (Finsch).

1897. *Paradisea minor jobiensis* Rothschild, Bull. Brit. Orn. Club, vol. vi, p. xlvi, May 29. Jobi I. = Japen (Dr. Guillemard, etc.).

1939. *Paradisaea minor pulchra* Mayr and de Schauensee, Proc. Acad. Nat. Sci. Philad., vol. 91, p. 151, Nov. 2. Tip, Misol, west of New Guinea.

Figured, Elliot, Mon. Paradis., pl. 4, 1873; Gould, Birds New Guinea, vol. i, pls. 28 and 29 (pt. x), 1879; Sharpe, Mon. Paradis, vol. i, pls. 25, 26 (pt. vii), 1897; described, Rothschild, Paradis., p. 40, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 874, 1930; Mayr, List New Guinea Birds, p. 178, 1941.

PARADISEA MARIA Reichenow. Plate xi, fig. 1.
MRS. REICHENOW'S BIRD-OF-PARADISE.

1894. *Paradisea maria* Reichenow, Orn. Monatsb., vol. ii, p. 22, Feb. Finisterre Mts., Huon Peninsula, 1,500 feet, North-Eastern New Guinea.

[1913. *Paradisea duivenbodei* Menegaux, Rev. Franç. d'Orn., vol. iii, p. 49, Apl. 7. "Pres d'Yaour, dans la baie Geelvink (M. Seng)", per M. R. de Duivenbode. Listed by Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Paradisaea minor finschi* and *Paradisaea gulielmi*, therefore type locality questioned to agree with supposition).]

Figured, Reichenow, Journ. für Orn., vol. 45, pl. 5, 1897; described, Rothschild, Paradis., p. 42, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 874, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Paradisaea apoda augustaevictoriae* and *Paradisaea gulielmi*).

PARADISEA BLOODI. Plate xix, fig. 4. BLOOD'S BIRD-OF-PARADISE.

Genus NEOPARADISEA van Oort.

1906. *Neoparadisea* van Oort, Notes Leyden Museum, vol. xxviii, p. 129, July. Haplotype *Neoparadisea ruysi* van Oort.

NEOPARADISEA RUYSI van Oort. Plate xiv, fig. 2. RUYS' BIRD-OF-PARADISE.

1906. *Neoparadisea ruysi* van Oort, Notes Leyden Museum, vol. xxviii, p. 129, July. Near Warsembo, West Coast of Geelvink Bay, Dutch New Guinea.

Listed, Mathews, Syst. Av. Australas., pt. ii, p. 878, 1930; Mayr, List New Guinea Birds, p. 182, 1941 (as hybrid between *Diphyllodes magnificus* and *Paradisaea minor*).

Genus URANORNIS Salvadori.

1876. *Uranornis* Salvadori, Ann. Mus. Civ. Genova, vol. ix, p. 191, footnote (dated Dec. 3). Haplotype *Paradisea rubra* Daudin.

URANORNIS RUBER Daudin. Plate xxi, figs. 1, 2. RED BIRD-OF-PARADISE.

1800. *Paradisea rubra* Daudin, Traite d'Orn., vol. ii, p. 271, ex Lacepede MS. New Guinea (Cab Hollande in Mus. d'Hist. Nat. Paris) = Waigiou.

1809. *Paradisea sanguinea* Shaw, Gen. Zool., vol. vii, p. 487, pl. (dated Sept. 1, 1808). New Guinea = Waigiou.

1858. *Paradisea coccinea* Horsfield and Moore, Cat. Birds Mus. East Ind. Co., vol. ii, p. 548, ex F.(B.) Hamilton MS., in synonymy.

Figured, Lesson, Voy. Coquille, pl. 2, ♀ (livr. 6), 1828; Elliot, Mon. Paradis., pl. 4, 1873; Gould, Birds New Guinea, vol. i, pl. 31 (pt. iv), 1877; Sharpe, Mon. Paradis., vol. i, pl. 28 (pt. iv), 1895; described, Rothschild, Paradis., p. 43, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 875, 1930; Mayr, List New Guinea Birds, p. 178, 1941.

Genus TRICHOPARADISEA Meyer.

1893. *Trichoparadisea* Meyer, Abh. Ber. K. Zool. Mus. Dresden, bd. iv, no. 3, p. 20. Haplotype *Paradisea guilielmi* Cabanis.

TRICHOPARADISEA GUILIELMI Cabanis. Plate xxi, figs. 3, 4.
WHITE-PLUMED BIRD-OF-PARADISE.

1888. *Paradisea guilielmi* Cabanis, Journ. für Orn., vol. 36, p. 119, Jan. no. Kaiser Wilhelm's Land, North-East New Guinea.

1889. *Paradisea guilielmi II* Cabanis, id., vol. 37, p. 62, pl. i, Jan. no. Figure and correction.

Figured, Sharpe, Mon. Paradis., vol. i, pl. 27 (pt. v), 1895; described, Rothschild, Paradis., p. 42, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 874, 1930; Mayr, List New Guinea Birds, p. 178, 1941.

Genus PARADISORNIS Finsch and Meyer.

1885. *Paradisornis* Finsch and Meyer, Zeitsch. ges. Orn., vol. ii, p. 385 (ex Meyer MS.). Haplotype *Paradisornis rudolphi* Finsch and Meyer.

PARADISORNIS RUDOLPHI Finsch and Meyer. Plate xx, figs. 3, 4.
BLUE BIRD-OF-PARADISE.

1885. *Paradisornis rudolphi* Finsch and Meyer, Zeitsch. ges. Orn., vol. ii, p. 385, pl. 20 (ex Finsch MS.). Astrolabe Mts., South-Eastern New Guinea (C. Hunstein).

1907. *Paradisornis rudolphi hunti* Le Souef, Emu, vol. vi, p. 119, Jan. 1. British New Guinea (Atlee Hunt).

1934. *Paradisea rudolphi ampla* Greenway, Proc. New Engl. Zool. Club, vol. 14, p. 1. Mt. Misim, Morobe; North-East New Guinea.

Figured, Sharpe, Mon. Paradis., vol. i, pl. 29 (pt. ii), 1893; described, Rothschild, Paradis., p. 43, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 875, 1930; Mayr, List New Guinea Birds, p. 178, 1941.

Subfamily MANUCODIINAE. MANUCODES AND PARADISE-CROWS.

Genus LYCOCORAX Bonaparte. PARADISE-CROWS.

1853. *Lycocorax* Bonaparte, Comptes Rendus Acad. Sci. Paris, vol. xxxvii, p. 829, note, Dec. 5/12. Haplotype *Corvus pyrrhopterus* Bonaparte.

LYCOCORAX PYRRHOPTERUS Bonaparte. Plate xiv, fig. 5. PARADISE-CROW.

1851. *Corvus pyrrhopterus* Bonaparte, Consp. Gen. Av., vol. i, pt. 2, p. 384, Feb. (ex Temminck MS.). Gilolo = Halmahera.

1863. *Lycocorax morotensis* Schlegel, Ibis, 1863, p. 119, Jan. I. Mortai. Also spelt *mortiensis* Gray, Handl. Gen. Sp. Birds, pt. ii, p. 17, 1870.

1864. *Lycocorax obiensis* Bernstein, Journ. für Orn., 1864, p. 410, Nov. no. Obi I.

Figured, Schlegel, Bijdr. Dierk, pt. 8, pl. 1, 1858; Gould-Sharpe, Birds New Guinea, vol. i, pl. 36 (pt. xxiv), 1888; Sharpe, Mon. Paradis., vol. ii, pl. 7 (pt. i), 1891; id., pl. 8 (*morotensis*) (pt. v), 1895; id., pl. 9 (*obiensis*) (pt. ii), 1893; described, Rothschild, Paradis., pp. 47148, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 882, 1930.

Genus MANUCODIA Boddaert. TRUE MANUCODES.

1783. *Manucodia* Boddaert, Tabl. Planch. Enlum., p. 39, December. Haplotype *Manucodia chalybea* Boddaert = *Paradisea chalybata* Forster.

1829. *Chalybaeus* Cuvier, Règne Animal, 2nd ed., vol. i, p. 354, Apl. 11. Haplotype *Chalybaeus paradisaeus* Cuvier = *Manucodia chalybea* Boddaert. Also spelt *Calybeus* and *Chalybeus* by Lesson, and *Chalyboea* and *Chalibaeus* by Schlegel.

MANUCODIA CHALYBATA Forster. Plate xxii, figs. 2, 4. GREEN MANUCODE.

1781. *Paradisea chalybata* Forster, Zool. Indische (Pennant), p. 40, based on New Guinea, Arfak Mts.

1783. *Manucodia chalybea* Boddaert, Tabl. Planch. Enlum., p. 39, December, based on Pl(anch.) Enlum, 634, Buff., v. p. 236. New Guinea.

1786. *Paradisaea viridis* Scopoli, Del Flor. et Faun. Insubr., pt. ii, p. 88, based on Sonnerat, Nov. Guin., p. 164, tab. 99. New Guinea.

1829. *Chalybaeus paradisaeus* Cuvier, Règne Animal, 2nd ed., vol. i, p. 354, Apl. 11. New name for *Paradisea viridis* Gmel., Enl., 634.

1875. *Manucodia jobiensis* Salvadori, Ann. Mus. Civ. Genova, vol. vii, p. 969, dated Dec. Jobi Island = Japen.

1885. *Manucodia rubiensis* Finsch and Meyer, Zeitsch. ges. Orn., vol. ii, p. 374 (ex Meyer MS.). Rubi, Geelvink Bay, Dutch New Guinea.

1896. *Manucodia orientalis* Salvadori, Ann. Mus. Civ. Genova, ser. 2, vol. xvi, p. 103 (dated Mch. 10). Genekarumu, South-East New Guinea (L. Loria).

Figured, Elliot, Mon. Paradis., pl. 6, 1873; Gould, Birds New Guinea, vol. i, pl. 34 (pt. v), 1877; Sharpe, Mon. Paradis., vol. ii, pl. 4 (pt. ii), 1893; described, Rothschild, Paradis., p. 45, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, pp. 880/1, 1930; Mayr, List New Guinea Birds, p. 168, 1941.

MANUCODIA ATRA Lesson and Garnot. Plate xxii, fig. 1.

GLOSSY-MANTLED MANUCODE.

1830. *Phonygama ater* Lesson and Garnot, Voy. Coquille, Zool., vol. i, p. 638 (livr. 14), Jan. 9. Dorey Harbour, North-West New Guinea.

1903. *Manucodia ater altera* Rothschild and Hartert, Nov. Zool., vol. x, p. 84, Apl. 20. Sudest Island, Louisiade Archipelago.

1929. *Manucodia atra subalter* Rothschild and Hartert, Bull. Brit. Orn. Club, vol. 49, p. 110, July 10. Dobbo, Aru Islands.

Figured, Elliot, Mon. Paradis., pl. 7, 1873; Sharpe, Mon. Paradis., vol. ii, pl. 5 (pt. viii), 1898; described, Rothschild, Paradis., p. 44, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 881, 1930; Mayr, List New Guinea Birds, p. 164, 1941.

Genus EUCORAX Sharpe.

1894. *Eucorax* Sharpe, Bull. Brit. Orn. Club, vol. iv, p. xv, Dec. 29. Orthotype *Manucodia comrii* Sclater.

EUCORAX COMRII Sclater. Plate xxii, fig. 3. CURLCRESTED MANUCODE.

1876. *Manucodia comrii* Sclater, Proc. Zool. Soc. (Lond.), 1876, p. 459, pl. 42, Oct. 1. "Huon Gulf, Northeast New Guinea" = ? D'Entrecasteaux Islands.

1936. *Manucodia comrii trobriandi* Mayr, Amer. Mus. Novit., no. 869, p. 3, July 2. Kaileuna, Trobriand Islands.

Figured, Gould, Birds New Guinea, vol. i, p. 33 (pt. v), 1877; Sharpe, Mon. Paradis., vol. ii, pl. 6 (pt. iii), 1894; described, Rothschild, Paradis., p. 45, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 882, 1930; Mayr, List New Guinea Birds, p. 168, 1941.

Genus PHONYGAMMUS Lesson and Garnot. EARED MANUCODES.

1826. *Phonygammus* Lesson and Garnot, Bull. Sci. Nat. (Ferussae), vol. viii, p. 110, March. Haplotype *Barita keraudrenii* Lesson and Garnot. Also spelt *Phonygama* Lesson, *Phonigama* Cabanis, *Phoneogama* Agassiz, *Phonygamia* Schlegel, and even *Phoniachema* Van d'Hoeven, for the sake of purism.

PHONYGAMMUS KERAUDRENII Lesson and Garnot. Plate xxiii, figs. 3, 4. TRUMPET-BIRD.

1826. *Barita keraudrenii* Lesson and Garnot, Bull. Sci. Nat. (Ferussac), vol. viii, p. 110, March. Dorey Harbour, North-West New Guinea.

1829. *Chalybaeus cornutus* Cuvier, Règne Animal, 2nd ed., vol. i, p. 354, Apl. 11. New name for preceding, based on Coquille plate.

1837. *Phonygama lessonia* Swainson, Classif. Birds, vol. ii, p. 264, July 1. New name for Lesson, Voy., pl. 13.

1859. *Manucodia gouldii* Gray, Proc. Zool. Soc. (Lond.), 1859, p. 158, note, Oct. 1. Cape York, North Australia, for bird figured by Gould, Birds Austr.

1877. *Phonygama jamesii* Sharpe, Cat. Birds Brit. Mus., vol. iii, p. 181, June (6). Aleya, near Yule I., South-East New Guinea.

1882. *Phonygama hunsteini* Sharpe, Journ. Linn. Soc. (Lond.), Zool., vol. xvi, p. 442, July 31. East Cape = Normanby I., D'Entrecasteaux Islands.

1885. *Phonygama purpureoviolacea* Finsch and Meyer, Zeitsch. ges. Orn., vol. ii, p. 375, pl. 15 (ex Meyer MS.). Astrolabe Mts., South-East New Guinea (C. Hunstein).

1889. *Manucodia thomsoni* Tristram, Ibis, 1889, p. 554, Oct. D'Entrecasteaux Islands.

1918. *Phonygammus neumanni* Reichenow, Journ. für Orn., 1918, p. 438. Lordberg, Sepik district, Northern New Guinea.

1924. *Phonygammus yorki* Mathews, Bull. Brit. Orn. Club, vol. xlv, p. 17, Oct. 29. Gin Creek, Cape York, North Queensland.

1942. *Phonygammus keraudreni mayri* Greenway, Proc. New Engl. Zool. Club, vol. xix, p. 51. Morobe district, North-East New Guinea.

Figured, Lesson, Voy. Coquille, livr. 1, pl. 13, 1826; Gould, Suppl. Birds Austr., pl. 9 (pt. ii), 1855; Elliot, Mon. Paradis., pl. 8, 1873; Gould-Sharpe, Birds New Guinea, vol. i, pl. 35 (pt. xxiii), 1857; Sharpe, Mon. Paradis., vol. ii, pl. i (pt. iv) (*keraudreni*), 1895; id., vol. ii, pl. 2 (pt. iii) (*purpureoviolacea*), 1894; id., pl. iii (pt. viii) (*hunsteini*), 1898; Mathews, Birds Austr., vol. xii, pl. 593, 1926;

described, Rothschild, Paradis., p. 46, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 579, 1930; Mayr, List New Guinea Birds, p. 169, 1941.

Families ? FALSE BIRDS OF PARADISE.

Genus PTERIDOPHORA Meyer.

1894. *Pteridophora* Meyer, Bull. Brit. Orn. Club, vol. iv, p. 11, Dec. 29. Haplotype *Pteridophora alberti* Meyer.

PTERIDOPHORA ALBERTI Meyer. Plate xxiv, figs. 1, 2. THE ENAMELLED BIRD.

1894. *Pteridophora alberti* Meyer, Bull. Brit. Orn. Club, vol. iv, p. 11, Dec. 29; id., Abh. ber. K. Mus. Dresden, vol. 5, no. 5, pl. 1, 1895. Mounts at River Amberno, New Guinea.

1931. *Pteridophora alberti burgersi* Rothschild, Nov. Zool., vol. 36, p. 253, Apl. 22. Schraderberg, Sepik district, North New Guinea.

Figured, Sharpe, Mon. Paradis., vol. i, pl. 38 (pt. vii), 1897; described, Rothschild, Paradis., p. 20, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 879, 1930; Mayr, List New Guinea Birds, p. 179, 1941.

Genus LORIA Salvadori.

1894. *Loria* Salvadori, Ann. Mus. Civ. Genova, vol. xxxiv, p. 151 (dated May). Haplotype *Loria loriae* Salvadori.

LORIA LORIAE Salvadori. Plate xxiv, figs. 4, 5. LORIA'S BIRD.

1894. *Loria loriae* Salvadori, Ann. Mus. Civ. Genova, vol. xxxiv (ser. 2, vol. 14), p. 151, dated May. Moroka, South-East New Guinea.

1894. *Cnemophilus mariae* De Vis, Ann. Rep. Brit. New Guinea, 1893-94, App. EE, p. 104, November. Mount Maneao, 5,650 feet, N.E. New Guinea (Armit and Guise).

1934. *Loria loria amethystina* Stresemann, Orn. Monatsb., vol. 42, p. 144, Sept. 16. Schraderberg, mid-Sepik district, North New Guinea (Burgers).

1939. *Loria loriae inexpectata* Junge, Nova Guinea (n.s.), vol. iii, p. 77. Bijenkorf, Oranje Mountains, Dutch New Guinea.

Figured, Sclater, Ibis, 1895, pl. 8; Sharpe, Mon. Paradis., vol. ii, pl. 18 (pt. vi), 1896; described, Rothschild, Paradis., p. 15, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 885, 1930; Mayr, List New Guinea Birds, p. 179, 1941.

Genus LOBOPARADISEA Rothschild.

1896. *Loboparadisea* Rothschild, Bull. Brit. Orn. Club, vol. vi, p. xv, Dec. 30. Orthotype *Loboparadisea sericea* Rothschild.

LOBOPARADISEA SERICEA Rothschild. Plate xxiv, fig. 3. SHIELD-BILL.

1896. *Loboparadisea sericea* Rothschild, Bull. Brit. Orn. Club, vol. vi, p. xvi, Dec. 30. Bought at Koeroedoe, Dutch New Guinea.

1930. *Loboparadisea sericea aurora* Mayr, Orn. Monatsb., vol. 38, p. 417, Sept. Dawong, Herzog Mts., North-East New Guinea (E. Mayr).

Figured, Rothschild, Nov. Zool., vol. iv, pl. 2, fig. 2, 1897; Sharpe, Mon. Paradis, vol. ii, pl. 17 (pt. vii), 1897; described, Rothschild, Paradis., p. 14, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 885, 1930; Mayr, List New Guinea Birds, p. 179, 1941.

Genus SEMIOPTERA Gray. PARADISE FRIAR-BIRDS.

1859. *Semioptera* Gray, Ibis, 1859, p. 210, Apl.; Proc. Zool. Soc. (Lond.), 1859, p. 130 (June); Ibis, 1859, p. 322, July; Ibis, 1859, p. 454, Oct. 1; Proc.

Zool. Soc. (Lond.), 1859, p. 130, October 1. Haplotype *Paradisea wallacii* Gray.

SEMIOPTERA WALLACII Gray. Plate xxiii, figs. 1, 2. STANDARD-WING.

1859. *Paradisea wallacii* Gray, Ibis, 1859, p. 210, Apl.; Proc. Zool. Soc. (Lond.), 1859, p. 130, June; Ibis, 1859, p. 322, July; Ibis, 1859, p. 454, Oct.; Proc. Zool. Soc. (Lond.), 1859, p. 130, Oct. Based on sketch sent by Wallace, Oct. 29, 1858, from Batchian.

1881. *Semioptera wallacei* var. *halmaherae* Salvadori, Ornit. Papu. e. Mol., vol. 2, p. 573, preface May. Halmahera.

1891. *Semioptera gouldi* Boucard, Humming Birds, vol. i, p. 43. Moluccas.

Figured, Gould, Birds Austr. Suppl., pl. 52 (pt. iii), Sept. 1, 1859; Elliot, Mon. Paradis, pl. 18, 1873; Sharpe, Mon. Paradis., vol. i, pl. 39 (pt. v), 1895; described, Rothschild, Paradis., p. 37, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 879, 1930.

Family PTILONORHYNCHIDAE. BOWER-BIRDS. (as a whole).
Subfamily SERICULINAE. ANOMALOUS BOWER-BIRDS.

Genus SERICULUS Swainson.

1825. *Sericulus* Swainson, Zool. Journ., vol. i, pt. iv, p. 476, Jan. Haplotype *Meliphaga chrysocephala* Lewin. Also spelt *Sericula* Voigt, Das Thierr. (Cuvier), vol. i, p. 505, 1831.

SERICULUS CHRYSOCEPHALUS Lewin. Plate xxv, figs. 3, 4. REGENT BIRD.

1808. *Meliphaga chrysocephala* Lewin, Birds New Holland, pl. vi, Sept. (Sydney) New South Wales.

1824. *Oriolus regens* Quoy and Gaimard, Voy. 'Uranie' et 'Physicienne', Zool., p. 105, Sept. 18. (Sydney) New South Wales.

1825. *Paradisea imperialis* Sieber, Isis (Oken), 1825, Beylage no. 1. Apparently only new name for *Oriolus regens* Q. & G.

1826. *Mel(iphaga) auricapilla* Stephens, Gen. Zool. (Shaw), vol. xiv, pt. i, p. 262 (end of year). New name for Lewin's Golden-crowned Honey Sucker.

1831. *Meliphaga regia* Voigt, Das Thierr. (Cuvier), vol. i, p. 505 (pref. Easter), as synonym of *regens* (as ex Lewin).

1838. *Sericulus magnirostris* Gould, Synops. Birds Austr., pt. iv, app. p. 2, Apl. 1. "Tasmania" error = New South Wales.

1846. *Sericulus melinus* Strickland, Gray, Gould and many authorities. Not *Turdus melinus* Latham, Index Orn., Suppl., p. xliv, 1801.

1912. *Sericulus chrysocephalus rothschildi* Mathews, Nov. Zool., vol. xviii, p. 441, Jan. 31. Blackall Ranges, South Queensland.

Figured, Gould, Birds Austr., vol. 4, pl. 12 (pt. xxvi), 1847; Elliot, Mon. Paradis., pl. 27, 1873; Sharpe. Mon. Paradis., vol. ii, pl. 7 (pt. v), 1895; Mathews, Birds Austr., vol. xii, pl. 588, 1926; described, Rothschild, Paradis., p. 13, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 889, 1930.

Genus XANTHOMELUS Bonaparte. GOLDEN BIRDS.

1854. *Xanthomelus* Bonaparte, Comptes Rendus Acad. Sci. Paris, vol. xxxviii, pp. 260/262, Feb. 6. Orthotype *Coracias aurea* Linné.

XANTHOMELUS AUREUS Linné. Plate xxvi, figs. 1, 2. GOLDEN BIRD.

1758. *Coracias aurea* Linné, Syst. Nat., 10th ed., p. 108, Jan. 1. Based on Mus Av. Fr., 1, p. 15, and Edw., Av., 112, t. 112. "In Asia" = New Guinea.

1766. *Oriolus aureus* Linné, Syst. Nat., 12th ed., vol. i, p. 163. On same basis as preceding. New generic location only.

1809. *Paradisea aurantia* Shaw, Gen. Zool., vol. vii, pt. ii, p. 499, pl. (dated Sept. 1, 1808). New name for *Coracias aurea* L.

1823. *Oriolus paradiseus* Dumont, Dict. Sci. Nat. (Levrault), vol. 27, p. 215, July 26. New name only (incorrectly written *aurantiacus* by Salvadori, Sharpe, Rothschild).

1830/1. *Sericulus aurantiacus* Lesson, Traité d'Orn., livr. 5, p. 339 (between Sept., 1830, and Feb., 1831). Merely emendation of *aurantia* Shaw.

1871. *Sericulus xanthogaster* Schlegel, Ned. Tijdschr. Dierk., vol. iv, p. 50. Arfak Mts., N.W. New Guinea. Based on juvenile according to Salvadori.

Figured, Elliot, Mon. Paradis., pl. 15 (*aureus*), pl. 33 (*Chlamydodera xanthogastra*), 1873; Gould, Birds New Guinea, vol. i, pl. 48 (pt. vi), 1878; Sharpe, Mon. Paradis., vol. ii, pl. 25 (pt. i), 1891; described, Rothschild, Paradis., p. 11, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 888, 1930; Mayr, List New Guinea Birds, p. 184, 1941.

XANTHOMELUS ARDENS D'Albertis and Salvadori. Plate xxvi, figs. 3, 4.
YELLOW-THROATED GOLDEN-BIRD.

1879. *Xanthomelus ardens* D'Albertis and Salvadori, Ann. Mus. Civ. Genova, vol. xiv, p. 113. Fly River, South New Guinea.

Figured, Sharpe, Mon. Paradis., vol. ii, pl. 26 (pt. vi) (incorrect), 1896; van Oort, Nova Guinea, vol. ix, Zool., pl. 3, 1909; Ogilvie-Grant, Ibis, 1915, Jubilee Suppl. 2, pl. i., Dec., 1915; described, Rothschild, Paradis., p. 11, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 888, 1930; Mayr, List New Guinea Birds, p. 184, 1941.

XANTHOMELUS BAKERI Chapin. Plate xxvii, figs. 3, 4. MADANG GOLDEN-BIRD.

1929. *Xanthomelus bakeri* Chapin, Amer. Mus. Nov., no. 367, p. 1, Aug. 9. Madang, North Coast New Guinea (R. Beck).

Figured, Natural History, vol. xxix, frontispiece, Nov.-Dec. no., 1929; listed, Mathews, Syst. Av. Australas., pt. ii, p. 888, 1930; Mayr, List New Guinea Birds, p. 184, 1941.

Genus CNEMOPHILUS De Vis. CRESTED GOLDEN-BIRDS.

1890. *Cnemophilus* De Vis, Ann. Rep. Brit. New Guinea, 1888-89, p. 61, Feb. 22. Haplotype *Cnemophilus macgregorii* De Vis. Also spelt *Nemophilus* Rothschild, Bull. Brit. Orn. Club, no. xli, 1897, and Ibis, 1897, p. 259.

CNEMOPHILUS MACGREGORII De Vis. Plate xxviii, figs. 2, 3.
CRESTED GOLDEN-BIRD.

1890. *Cnemophilus macgregorii* De Vis, Ann. Rep. Brit. New Guinea, 1888-89, p. 61, Feb. 22. Mt. Knutsford, 11,000 feet, South-East New Guinea.

1890. *Xanthomelus macgregori* Goodwin, Ibis, 1890, p. 153, Apl. 1. Based on the same specimen. Mt. Owen Stanley, British New Guinea.

Figured, Ibis, 1891, pl. 10; Sharpe, Mon. Paradis., vol. ii, pl. 23 (pt. iv), 1895; described, Rothschild, Paradis., p. 15, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 887, 1930; Mayr, List New Guinea Birds, p. 183, 1941.

CNEMOPHILUS MACGREGORII SANGUINEUS. Plate xxvii, fig. 2; Plate xxviii, fig. 1.

Subfamily AMBLYORNITHINAE. GARDENER BOWER-BIRDS.

Genus AMBLYORNIS Elliot.

1872. *Amblyornis* Elliot, Ibis, 1872, p. 113, Apl. Haplotype *Ptilorhynchus inornatus* Schlegel. Also spelt *Ambliornis* Salvadori, Ann. Mus. Civ. Genova, vol. viii, p. 780, 1875/6.

1894. *Xanthochlamys* Sharpe, Bull. Brit. Orn. Club, vol. 4, p. xv, Dec. 29. Orthotype *Amblyornis subalaris* Sharpe.

AMBLYORNIS INORNATUS Schlegel. Plate xxx, fig. 4. GARDENER BOWER-BIRD.

1871. *Ptilorhynchus inornatus* Schlegel, Ned. Tijdschr. Dierk., vol. iv, p. 51. Arfak Mountains, North-West New Guinea.

Figured, Elliot, Mon. Paradis., pl. 37, 1873; Gould, Birds New Guinea, vol. i, pl. 46 (pt. ix), 1879; Sharpe, Mon. Paradis., vol. ii, pl. 21 (pt. iii), 1893; described, Rothschild, Paradis., p. 12, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 886, 1930; Mayr, List New Guinea Birds, p. 183, 1941.

AMBLYORNIS MACGREGORIAE De Vis. Plate xxix, figs. 3, 4.
CRESTED GARDENER-BIRD.

1890. *Amblyornis macgregoriae* De Vis, Ann. Rep. Brit. New Guinea, 1888-89, App., p. 61, Feb. 22. Musgrave Range, 7,000–9,000 feet, South-East New Guinea.

1890. *Amblyornis musgravii* Goodwin, Proc. Zool. Soc. (Lond.), 1889, p. 451, Apl. 1. Mount Musgrave, Brit. New Guinea, 10,000 feet.

1890. *Amblyornis musgravianus* Goodwin, Ibis, 1890, p. 153, Apl. 1. Same bird.

1910. *Amblyornis inornatus germanus* Rothschild, Bull. Brit. Orn. Club, vol. xxvii, p. 13, Nov. 4. Rawlinson Mts., North-Eastern New Guinea.

1930. *Amblyornis inornatus mayri* Hartert, Novit. Zool., vol. 36, p. 30, Nov. 15. Probably Karon, northern Vogelkop = ? Weyland Mts., New Guinea.

1931. *Amblyornis inornatus aedificans* Mayr, Mitt. zool. Mus. Berlin, vol. 17, p. 648, Dec. Dawong, Herzog Mts., North-East New Guinea (Mayr).

1931. *Amblyornis inornatus longicristatus* Mayr, Mitt. zool. Mus. Berlin, vol. 17, p. 649, Dec. Mt. Goliath, Dutch New Guinea (A. S. Meek).

Figured, Sharpe, Mon. Paradis., vol. ii, pl. 20 (pt. viii), 1898; Rothschild, Nov. Zool., vol. 3, pl. 1, 1896; described, Rothschild, Paradis., p. 12 (*inornata*), 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 886, 1930; Mayr, List New Guinea Birds, p. 183, 1941.

AMBLYORNIS SUBALARIS Sharpe. Plate xxix, figs. 1, 2.
ORANGE-CRESTED GARDENER-BIRD.

1884. *Amblyornis subalaris* Sharpe, Journ. Linn. Soc. (Lond.), Zool., vol. xvii, p. 408, Sept. 18. Astrolabe Mts., South-East New Guinea (Goldie).

Figured, Finsch and Meyer, Zeitschr. ges. Orn., vol. ii, pl. xxii, 1885; Gould-Sharpe, Birds New Guinea, vol. i, pl. 47 (pt. xxii), 1886; Sharpe, Mon. Paradis., vol. ii, pl. 22 (pt. iii), 1894; described, Rothschild, Paradis., p. 12, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 887, 1930; Mayr, List New Guinea Birds, p. 184, 1941.

AMBLYORNIS FLAVIFRONS Rothschild. Plate xxx, fig. 3.
YELLOW-FRONTED GARDENER-BIRD.

1895. *Amblyornis flavifrons* Rothschild, Nov. Zool., vol. ii, p. 480, December 30. Dutch New Guinea.

Figured, Rothschild, Nov. Zool., vol. 3, pl. 1, figs. 3, 4, 1896; Sharpe, Mon. Paradis., vol. ii, pl. 20 (pt. viii), 1898; described, Rothschild, Paradis., p. 12, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 887, 1930; Mayr, List New Guinea Birds, p. 184, 1941.

Genus PRIONODURA De Vis.

1883. *Prionodura* De Vis, Proc. Linn. Soc. New South Wales, vol. vii, p. 561, Apl.; ex Abstr. Proc. Linn. Soc. New South Wales, for Nov. 29, 1882, p. 1. Nomen nudum. Haplotype *Prionodura newtoniana* De Vis.

1889. *Corymbicola* Meston, Rep. Sci. Exped. Bellenden Ker Range, North Queensland, 8vo ed., p. 120; not in 4to ed., p. 32 later; ex *Queensland Courier*, Oct. 4, De Vis. Haplotype *Corymbicola mestoni* De Vis = Meston.

PRIONODURA NEWTONIANA De Vis. Plate xxv, figs. 1, 2. NEWTON'S BOWER-BIRD.

1883. *Prionodura newtoniana* De Vis, Proc. Linn. Soc. New South Wales, vol. 7, p. 562, Apl.; ex Abstr. Proc. Linn. Soc. N.S.W., for Nov. 29, 1882. Nomen nudum. Tully River Scrubs, North Queensland.

1889. *Corymbicola mestoni* Meston, Rep. Sci. Exped. Bellenden Ker Range, North Queensland, p. 120; ex *Queensland Courier*, Oct. 4, 1889, De Vis. Bellenden Ker Range, 5,000 feet, North Queensland.

1915. *Prionodura newtoniana fairfaxi* Mathews, Austral. Avian Record, vol. ii, p. 133, Jan. 28. Bartlefrere, 3,800 feet, North Queensland.

Figured, Sharpe, Mon. Paradis., vol. ii, pl. 24 (pt. i), 1891; Mathews, Birds Austr., vol. xii, pl. 589, 1926; described, Rothschild, Paradis., p. 13, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 888, 1930.

Genus ARCHBOLDIA Rand.

1940. *Archboldia* Rand, Amer. Mus. Novit., no. 1072, p. 9, June 26. Orthotype *Archboldia papuensis* Rand.

ARCHBOLDIA PAPUENSIS Rand. Plate xxvii, fig. 1. ARCHBOLD'S BOWER-BIRD.

1940. *Archboldia papuensis* Rand, Amer. Mus. Novit., no. 1072, p. 9, June 26. Bele River (2,200 M.), near Lake Habbema, Snow Mts., Dutch New Guinea.

Listed, Mayr, List New Guinea Birds, p. 183, 1941.

Subfamily AILUROEDINAE. CAT-BIRDS.

Genus AILUROEDUS Cabanis.

1851. *Ailuroedus* Cabanis, Mus. Heine., vol. i, p. 213, note (after Oct. 23). Haplotype *Ptilonorhynchus smithii* V. & H. = *Lanius crassirostris* Paykull. Also spelt *Alluroedus* Bonaparte, and *Aeluroedus* Sclater (Ibis, 1868, p. 501), and others.

1855. *Chlorokitta* Gray, List Gen. Subgen. Birds, p. 148, as of "Kaup" in synonymy.

1926. *Buccokitta* Mathews, Birds Austr., vol. xii, p. 313, Oct. 28. Orthotype *Kitta buccoides* Temminck and Laugier.

AILUROEDUS CRASSIROSTRIS Paykull. Plate xxxi, fig. 4. GREEN CAT-BIRD.

1815. *Lanius crassirostris* Paykull, Nov. Act. Reg. Soc. Sci. Upsal., vol. vii, p. 283. Sydney, New South Wales.

1817. *Coracina viridis* Vieillot, Nouv. Dict. d'Hist. Nat., nouv. ed., vol. viii, p. 9, Mch. 15. Sydney, New South Wales.

1826. *Kitta virescens* Temminck and Laugier, Planch. Color. d'Ois., livr. 67, pl. 396 (vol. iv), July 12. Sydney, New South Wales.

1826. *P(tilonorhynchus) viridis* Stephens, Gen. Zool. (Shaw), vol. xiv, pt. i, p. 72 (end of year). "South Sea Islands" = Sydney, New South Wales.

1827. *Ptilonorhynchus smithii* Vigors and Horsfield, Trans. Linn. Soc. (Lond.), vol. xv, p. 264, Feb. 17. Sydney, New South Wales.

1900. *Ailuroedus viridis* auctorum, but not *Gracula viridis* Latham, 1801, which is an Oriole.

1912. *Ailuroedus crassirostris blaauwi* Mathews, Nov. Zool., vol. xviii, p. 439, Jan. 31. Richmond River, Northern New South Wales.

Figured, Gould, Birds Austr., vol. iv, pl. 4 (pt. xxi), 1845; Elliot, Mon. Paradis., pl. 34, 1873; Sharpe, Mon. Parad., vol. ii, pl. 36 (pt. iii), 1894; Mathews, Birds Austr., vol. xii, pl. 583, 1926; described, Rothschild, Paradis., p. 5, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 892, 1930.

AILUROEDUS MELANOTIS Gray. Plate xxxi, figs. 1, 2, 3. BLACK-EARED CAT-BIRD.

1858. *Ptilonorhynchus melanotis* Gray, Proc. Zool. Soc. (Lond.), 1858, p. 181, July 13. Aru Islands (A. R. Wallace).

1874. *Ailuroedus arfakianus* Meyer, Sitzb. Akad. Wiss. Wien., vol. 69, p. 82 (Feb. 26 mtg.). Arfak Mts., 3,500 feet, North-West New Guinea.

1875. *Aeluroedus maculosus* Ramsay, Proc. Zool. Soc. (Lond.), 1874, p. 601, Apl. 1, 1875. Cardwell, North Queensland.

1883. *Aeluroedus melanocephalus* Ramsay, Proc. Linn. Soc. New South Wales, vol. viii, p. 25, June 19. Astrolabe Mts., South-Eastern New Guinea.

1895. *Aeluroedus jobiensis* Rothschild, Bull. Brit. Orn. Club, vol. 4, p. xxvi, March 30. "Jobi I." = may be error and = mainland opposite eastern end of Japen.

1915. *Ailuroedus melanotus fairfaxi* Mathews, Austral Avian Rec., vol. ii, p. 132, Jan. 28. Bellenden Ker Range, North Queensland.

1922. *Ailuroedus melanotis guttaticollis* Stresemann, Orn. Monatsb., vol. xxx, p. 35, Mch. 1. Hunsteinspitze, Sepik district, North New Guinea (Bürgers).

1931. *Ailuroedus melanotis astigmaticus* Mayr, Mitt. zool. Mus. Berlin, vol. 17, p. 47, Dec. Ogeramnang, Saruwaged Mts., North-East New Guinea.

1936. *Ailuroedus crassirostris facialis* Mayr, Amer. Mus. Novit., no. 869, p. 4, July 2. Utakwa River, Snow Mts., Dutch New Guinea.

1939. *Ailuroedus crassirostris misoliensis* Mayr and De Schauensee, Proc. Acad. Nat. Sci. Philad., vol. 91, p. 152, Nov. 2. Tip, Misol I., W. New Guinea.

1942. *Ailuroedus melanotis joanae* Mathews, Emu, vol. 40, p. 384, Apl. 1. Cape York, North Queensland.

Figured, Elliot, Mon. Paradis., pl. 35, 1873; Gould, Birds New Guinea, vol. i, pl. 39 (*melanotis*), pt. i, 1875; id., ib., pl. 40 (*arfakianus*) (pt. i), 1875; id., ib., pl. 38 (*maculosus*) (pt. i), 1875; Gould-Sharpe, ib., pl. 42 (pt. xxiv) (*melanocephalus*), 1888; Sharpe, Mon. Paradis., vol. ii, pl. 32 (*melanotis*), pl. 33 (*arfakianus*) (pt. iv), 1895; pl. 35 (*maculosus*) (pt. v), 1895; pl. 34 (*melanocephalus*) (pt. vii), 1897; Mathews, Birds Austr., vol. xii, pl. 583, 1926; described, Rothschild, Paradis., pp. 5/7, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 892, 1930; Mayr, List New Guinea Birds, p. 185, 1941.

AILUROEDUS BUCCOIDES Temminck and Laugier. Plate xxx, fig. 1.
WHITE-EARED CAT-BIRD.

1835. *Kitta buccoides* Temminck and Laugier, Planch. Color. d'Ois., 97^{e} livr. (vol. ii, pl. 575). Lobo Bay, South-West New Guinea.

1876. *Aeluroedus stonii* Sharpe, Nature, Vol. xiv, p. 339, Aug. 17. Laroki River, South-East New Guinea (O. C. Stone, Petterd and Broadbent).

1891. *Aeluroedus geislerorum* Meyer, Abh. Ber. K. Zool. Mus. Dresden, 1890–91, vol. iv, p. 12. Astrolabe Bay, North-East New Guinea.

1897. *Aeluroedus subcaudalis* De Vis, Ibis, 1897, p. 390, July; Ann. Rep. Brit. New Guinea, 1896-7, App. AA, p. 89, Apl. 1898. Mt. Scratchley (?), Brit. New Guinea.

1913. *Ailuroedus buccoides oorti* Rothschild and Hartert, Nov. Zool., vol. xx, p. 526, Oct. 1. Waigiu (John Waterstradt).

1929. *Ailuroedus buccoides molestus* Rothschild and Hartert, Nov. Zool., vol. xxxv, p. 59, Jan. 25. Haidana, Collingwood Bay, North-East New Guinea.

Figured, Elliot, Mon. Paradis, pl. 36, 1873; Gould, Birds New Guinea, vol. i, pl. 41 (pt. i), 1875; id., ib., pl. 37 (*stonii*) (pt. xii), 1881; Sharpe, Mon. Paradis., vol. ii, pl. 37 (*buccoides*) (pt. iv), 1895; pl. 38 (*geislerorum*) (pt. v), 1895; pl. 39 (*stonii*) (pt. ii), 1893; described, Rothschild, Paradis., p. 6, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 893, 1930; Mayr, List New Guinea Birds, p. 186, 1941.

Genus SCENOPOEETES Coues.

1891. *Scenopoeetes* Coues, Auk, vol. viii, p. 115, January. New name for
1876. *Scenopoeus* Ramsay, Proc. Zool. Soc. (Lond.), 1875, p. 591, Apl. 1, 1876. Haplotype *Scenopoeus dentirostris* Ramsay. Not *Scenopoeus* Agassiz, Index Univers., 12mo ed., p. 963, 1848.
1891. *Tectonornis* Sharpe, Mon. Paradis., pt. i, text to plate 40 (end of year). New name for *Scenopoeus* Ramsay.

SCENOPOEETES DENTIROSTRIS Ramsay. Plate xxx, fig. 2. TOOTH-BILLED CAT-BIRD.
1876. *Scenopoeus dentirostris* Ramsay, Proc. Zool. Soc. (Lond.), 1875, p. 591, Apl. 1, 1876. Bellenden Ker Range, 3,000–4,000 feet, North Queensland.
1915. *Scenopoeetes dentirostris minor* Mathews, Austral Avian Rec., vol. ii, p. 132, Jan. 28. Johnstone River, North Queensland.

Figured, Gould, Birds New Guinea, vol. i, pl. 43 (pt. x), 1879; Sharpe, Mon. Paradis., vol. ii, pl. 40 (pt. i), 1891; Mathews, Birds Austr., vol. xii, pl. 582, 1926; described, Rothschild, Paradis., p. 8, 1898; listed, Mathews, Syst. Av. Australas, pt. ii, p. 889, 1930.

Subfamily PTILONORHYNCHINAE.

Genus PTILONORHYNCHUS Kuhl.

1820. *Ptilonorhynchus* Kuhl, Beitr. Vergl. Anat., p. 150 (pref. Apl. 9). Haplotype *Pyrrhocorax violaceus* Vieillot. Also spelt *Ptilorhynchus* Cabanis, *Ptelenorhynchus* Temminck, and *Ptinolorhynchus* Lesson.
1826. *Kitta* Temminck and Laugier, Planch. Color. d'Ois., 67ᵉ livr. (vol. iv, pl. 395), July 12. Orthotype *Pyrrhocorax violaceus* Vieillot. Also spelt *Citta* Wagler, 1827.

PTILONORHYNCHUS VIOLACEUS Vieillot. Plate xxxii, figs. 3, 4. SATIN BOWER-BIRD.
1816. *Pyrrhocorax violaceus* Vieillot, Nouv. Dict. d'Hist. Nat., nouv. ed., vol. vi, p. 569, Dec. 14. (Sydney) New South Wales.
1820. *Ptilonorhynchus holosericeus* Kuhl, Beitr. Vergl. Anat., p. 150 (pref. Apl. 9) (ex Robert Brown MS.). Port Hacking, New South Wales.
1820. *Corvus squamulosus* Kuhl, ib., in synonymy based on female or young male.
1826. *Pt(ilonorhynchus) violaceus* Stephens, Gen. Zool. (Shaw), vol. xiv, pt. i, p. 72 (end of year). "South Sea Islands" = New South Wales.
1826. *Pt(ilonorhynchus) niger*, id., ib., based on Satin Grakle, Latham. New Holland.
1827. *Ptilonorhynchus macleayi* Vigors and Horsfield, Trans. Linn. Soc. (Lond.), vol. xv, p. 263, Feb. 17, based on same bird as Kuhl's name. Port Hacking, New South Wales.
1827. *Ptilonorhynchus squamulosus* Wagler, Syst. Avium, *Ptilono.* sp. 2, Oct. 4, ex Illiger MS. New Holland, based on female or young male.
1912. *Ptilonorhynchus violaceus dulciae* Mathews, Nov. Zool., vol. xviii, p. 438, Jan. 31. "Queensland."
1912. *Ptilonorhynchus minor* A. J. Campbell, Emu, vol. xii, p. 19, July 1 (ex Bull. Roy. Austr. Orn. Union, no. 3, May 21, 1912, privately distributed). Herberton, North Queensland.

Figured, Gould, Birds Austr., vol. 4, pl. 10 (pt. iv), 1841; Elliot, Mon. Paradis., pl. 28, 1873; Sharpe, Mon. Paradis., vol. ii, pl. 19 (pt. vi), 1896; Mathews, Birds Austr., vol. xii, pl. 581, 1926; described, Rothschild, Paradis., p. 4, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 886, 1930.

PTILONORHYNCHUS RAWNSLEYI Diggles. Plate xxx, fig. 5. RAWNSLEY'S SATIN-BIRD.

1868. *Ptilonorhynchus rawnsleyi* Diggles, Orn. Austr., pt. xv. Near Brisbane, South Queensland.

Figured, Gould, Birds Austr., Suppl., pl. 34 (pt. v), 1869; Elliot, Mon. Paradis., pl. 29, 1873; listed, Mathews, Syst. Av. Australas., pt. ii, p. 886, footnote, 1930, as "based on an aberration or hybrid".

Subfamily CHLAMYDERINAE.

Genus CHLAMYDERA Gould.

1837. *Chlamydera* Gould, Birds Austr. and Adj. Islands, pt. i, pl. 3, note, August. Also spelt *Chlamydodera* Agassiz, and many succeeding writers. Haplotype *Calodera maculata* Gould. New name for

1837. *Calodera* Gould, Synops. Birds Austr., pt. i, pl. 6, Jan. Logotype (Sharpe, 1881) *Calodera maculata* Gould. Also spelt *Callidera* Agassiz. Not *Calodera* Mannerheim, 1831.

1912. *Rogersornis* Mathews, Austral Avian Rec., vol. i, p. 117, Dec. 24. Orthotype *Ptilonorhynchus nuchalis* Jardine and Selby.

1914. *Alphachlamydera* Mathews, Austral Avian Rec., vol. ii, p. 112, Sept. 24. Orthotype *Chlamydera cerviniventris* Gould.

1926. *Pseudochlamydera* Mathews, Bull. Brit. Orn. Club, vol. xlvi, p. 60, Jan. 30. Orthotype *Chlamydodera lauterbachi* Reichenow.

CHLAMYDERA MACULATA Gould. Plate xxxiii, figs. 1, 4. SPOTTED BOWER-BIRD.

1837. *Calodera maculata* Gould, Synops. Birds Austr., pt. i, pl. 6, Jan. (Sydney) New South Wales.

1862. *Chlamydera guttata* Gould, Proc. Zool. Soc. (Lond.), 1862, p. 162, Oct. 1. North-Western Australia (F. J. Gregory) = Gascoyne River.

1875. *Chlamydodera occipitalis* Gould, Ann. Mag. Nat. Hist., ser. 4, vol. xvi, p. 429, Dec. 1. "Port Albany, North Queensland", error = New South Wales.

1912. *Chlamydera maculata clelandi* Mathews, Nov. Zool., vol. xviii, p. 439, Jan. 31. South Australia.

1912. *Chlamydera maculata subguttata* Mathews, Nov. Zool., vol. xviii, p. 440, Jan. 31. East Murchison, mid-West Australia.

1913. *Chlamydera maculata macdonaldi* Mathews, Austral Avian Rec., vol. ii, p. 78, Dec. 29. "McDonald" = Macdonnell Ranges, Central Australia.

1913. *Chlamydera maculata sedani* Mathews, Austral Avian Rec., vol. ii, p. 78, Dec. 29. "Gloncurry" = Cloncurry River, Queensland.

1920. *Chlamydera maculata nova* Mathews, Bull. Brit. Orn. Club, vol. xl, p. 76, Jan. 30. North-West Cape, mid-West Australia.

1920. *Chlamydera maculata carteri* Carter and Mathews, Ibis, 1920, p. 499, pl. 14, Apl. 1 (ex Mathews MS.). New name for *nova*, not *Alphachlamydera cerviniventris nova* Mathews, 1915.

Figured, Gould, Birds Austr., vol. 4, pl. 8 (pt. iv), 1841; Gould, Birds Austr., Suppl., pl. 35 (pt. iv), 1867; Elliot, Mon. Paradis., pl. 30, 1873; Gould, Birds New Guinea, vol. i, pl. 45 (pt. x) (*occipitalis*), 1879; Sharpe, Mon. Paradis., vol. ii, pl. 28, fig. 1 (pt. viii), 1898; id., ib., pl. 29 (*occipitalis*), pt. iii, 1894; Mathews, Birds Austr., vol. xii, pls. 584–5, 1926; described, Rothschild, Paradis., pp. 9/10, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 890, 1930.

CHLAMYDERA LAUTERBACHI Reichenow. Plates xxvii, f. 4, xxviii, f. 4.

LAUTERBACH'S BOWER-BIRD.

1897. *Chlamydera lauterbachi* Reichenow, Orn. Monatsb., vol. v, p. 24, Feb.; Journ. für Orn., 1897, p. 215, pl. 6, July no. Jagei River, Northern New Guinea.

1931. *Chlamydera lauterbachi uniformis* Rothschild, Nov. Zool., vol. 36, p. 250, Apl. 22. Siriwo River, south of Geelvink Bay, Dutch New Guinea (Shaw Mayer).

Described, Rothschild, Paradis., p. 9, 1898; listed, Mathews, Syst. Av Australas., pt. ii, p. 891, 1930; Mayr, List New Guinea Birds, p. 185, 1941.

CHLAMYDERA NUCHALIS Jardine and Selby. Plate xxxii, figs. 1, 2.

GREAT BOWER-BIRD.

1830. *Ptilonorhynchus nuchalis* Jardine and Selby, Illustr. Ornith., vol. ii, pl. ciii, Dec. = North Queensland.

1879. *Chlamydera orientalis* Gould, Ann. Mag. Nat. Hist., ser. 5, vol. 5, p. 74, July 1. North Queensland.

1912. *Chlamydera nuchalis oweni* Mathews, Nov. Zool., vol. xviii, p. 440, Jan. 31. Point Torment, North-West Australia.

1912. *Chlamydera nuchalis melvillensis* Mathews, Austral Avian Rec., vol. i, p. 52, Apl. 2. Melville Island, Northern Territory.

Figured, Gould, Birds Austr., vol. 4, pl. 9 (pt. iv), 1841; Elliot, Mon. Paradis., pl. 31, 1873; Gould, Birds New Guinea, vol. i, pl. 44 (pt. xi), 1880; Sharpe, Mon. Paradis., vol. ii, pl. 29 (*nuchalis*) (pt. viii), 1898; pl. 30 (*orientalis*) (pt. i), 1891; Mathews, Birds Austr., vol. xii, pls. 586/587, 1926; described, Rothschild, Paradis., p. 10, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 891, 1930.

CHLAMYDERA CERVINIVENTRIS Gould. Plate xxxiii, figs. 2, 3.

FAWN-BREASTED BOWER-BIRD.

1850. *Chlamydera cerviniventris* Gould, Contr. Ornith. (Jardine), p. 160 = 106. Cape York, North Queensland. Also misspelt *cerviniceps* Hartlaub, Arch. für Nat., xvii, pt. 2, p. 58, 1851.

(1895. *Chlamydodera recondita* Meyer, Abh. Ber. zool. Mus. Dresden, vol. 5, no. 10, p. 2, based on egg from Constantinhafen, Astrolabe Bay, North-East New Guinea.)

1915. *Alphachlamydera cerviniventris nova* Mathews, Austral Avian Rec., vol. ii, p. 132, Jan. 28. New Guinea = Port Moresby area.

Figured, Gould, Birds Austr., Suppl., pl. 36 (pt. iii), 1859; Elliot, Mon. Paradis., pl. 32, 1873; Sharpe, Mon. Paradis., vol. i, pl. 30 (pt. viii), 1898; Mathews, Birds Austr., pl. xii, pl. 586, 1926; described, Rothschild, Paradis., p. 9, 1898; listed, Mathews, Syst. Av. Australas., pt. ii, p. 891, 1930; Mayr, List New Guinea Birds, p. 185, 1941.

THE ZOO-GEOGRAPHICAL PROBLEM OF PORT JACKSON. PART 2.—CLASSIFICATION OF HABITATS.

By Charles F. Laseron.

(Text-figs. 1–2.)

In the first part of this paper, general principles were outlined, and a number of factors listed likely to influence the distribution of marine life in any given area. The first of these factors was then dealt with in some detail, that of the physiography of Port Jackson and the adjacent coast, both as it is now and as it was in the geological past. The other factors are now to be considered, particularly the effect they are likely to have in restricting the distribution of species to certain locations and thus producing defined ecological communities.

For the foreshore, that is the area between extreme high and low tide, this work has been particularly well done by the late Charles Hedley (1915). This has been supplemented by Miss Elizabeth Pope (1943) with a paper on "The Ecology of Long Reef". It is not proposed to deal further with this zone, but the main conclusion resulting from this study of the littoral has some bearing on the possible classification of deeper water habitats. This is the division of the littoral area into well-marked vertical zones, each with its distinctive fauna and flora, ranging from extreme high tide to that area only exposed at the lowest spring tides. Does this zoning continue below low tide and to what extent, or do factors other than depth come into play? The possible factors have already been outlined as: (1) Temperature, (2) Light, (3) Pressure, (4) Salinity, (5) Food, (6) Protection, (7) Ocean and Tidal Currents, (8) Nature of the Sea Bottom. These are now considered in more detail.

Temperature.

In the main body of the ocean, seasonal changes of temperature only take effect to a comparatively small depth, and there is a general gradual decrease to nearly freezing point and then a small rise to 4°F., which is the maximum density of seawater. This is the prevailing temperature of the lower layers of water in the abysmal depth of the ocean.

Port Jackson is, however, comparatively shallow, the average depth about 60 feet, the maximum, in a few deep holes, not more than 120 feet. This depth is too small to allow any appreciable decrease in temperature from depth alone, and sun and air temperatures as well as ocean currents are the determining factors.

Some figures are available, but unfortunately they are far from complete. For most of these I am indebted to the Maritime Services Board of New South Wales, and for others to The Taronga Zoological Park Trust.

From Fort Macquarie, which may be taken as a typical central harbour location, a series of temperatures from one foot below the surface, covering the period 31st May, 1943, to 27th May, 1944, ranges between a minimum of 54°F. to a maximum of 74·5°F.

From Athol Bight, the intake pipe for the aquarium at the Zoological Gardens is at a fixed point 10 feet below low-tide mark, and temperatures are continually taken to regulate the water for the aquarium itself. The Secretary, Mr. Brown, informs me that the maximum temperature of 76°F. was registered in January, 1946, and a minimum of 53°F. in August, 1945. No sudden changes due to causes other than seasonal have ever been noticed.

The following tables, also from the Maritime Services Board, only cover part of the year, but they are the only ones available for the deeper parts of the harbour. The readings were taken by Mr. D. D. Moore. Temperatures are in degrees Fahrenheit.

Bantry Bay, Middle Harbour.

Depth.	31.3.42. 9-10 a.m.	2.4.42. 2 p.m.	13.4.42. 9-10 a.m.	20.4.42. 9-10 a.m.	4.5.42. 9-10 a.m.	11.5.42. 2 p.m.
0·1 ft.	67·7	71·5	69·4	68·5	69·0	66·0
2·5 „	67·7	70·5				
5·0 „	68·3	70·0				
10·0 „	68·2	69·5	69·4	67·9	68·5	66·0
15·0 „	68·0	69·1				
20·0 „	68·6	69·0	69·3	67·7	68·0	66·3
30·0 „	68·3	69·2		68·3	68·0	66·0
40·0 „		69·3	69·4	68·4	68·0	66·0
60·0 „		69·5				
Tide	3/4, falling	Low, falling	High, falling	3/4, rising	3/4, falling	1/2, rising

Walsh Bay.

Depth.	1.4.42. 2 p.m.	15.4.42. 4 p.m.	22.4.42. 2 p.m.	30.4.42. 3 p.m.	5.5.42. 3 p.m.	13.5.42. 3 p.m.
0–1 ft.	72·5	67·7	68·5	68·9	69·5	65·0
15·0 „	70·0					
20·0 „		68·0	67·8	68·5	69·0	65·0
Tide	Low, rising	Low, rising	3/4, falling	1/4, rising	1/2, falling	1/2, rising

From these readings, though far from comprehensive, certain conclusions can be made. Thus the extreme temperatures of the surface waters of Port Jackson can be taken as between approximately 50° and 76°F. In the deeper water the results are rather surprising. It was expected that though seasonal changes took place, they would be much less than on the surface, and that in the summer months at least, the water would remain appreciably colder. No figures are available for mid-summer, that is from December to February, and possibly at this time the deeper water is a few degrees colder than the surface, but by March the lag has been overtaken and the whole body of water has become warmed nearly uniformly throughout. On the 2nd April, there is only a difference of 2° between the surface and 60 feet, while on the 11th May, while the whole has fallen 5° to 66°, the temperature is uniform from the surface to 40 feet. From this it can be deduced that the bottom temperature is never appreciably lower than the surface, except perhaps in some of the deeper holes where the water is still. In the winter, the chilling of the surface water might even for very short periods make it actually colder than at the bottom, but convection currents would make adjustment even more rapid, and uniformity would be soon restored. In other words the temperature curves of both surface and bottom waters practically conform, with a minimum of about 50° in winter, and with the surface perhaps 2° or 3° warmer in mid-summer. This would not apply to the very shallow water at the head of bays and inlets, where locally, and for short periods, extremes both of heat and cold, might be considerably exceeded.

From the faunal point of view, it is generally recognized that the range of species is more limited by minimum than by maximum temperatures, and adopting this as a datum, the marine isotherm passing through Port Jackson would be in the vicinity of 50° or a degree or so higher.

Within the harbour itself, as organisms in both deep and shallow waters live within almost exactly the same range of temperature, this condition is no bar to their migration from one to the other. Thus from this factor alone no zoning of the fauna in depth can be expected, though some change can be expected where very shallow water in the heads of inlets makes for greater extremes.

Light and Pressure.

There are very little data available for either of these two factors. The effects of light may be deduced to a certain extent by the distribution of the algae. It can be said that the whole of the waters of Port Jackson are within the zone of the brown weeds. These grow freely from just below low tide to the floor of the harbour, showing that sufficient light penetrates to propagate their growth. In fact, if brown algae be used as a faunal zone guide, depths far beyond anything in the harbour are indicated. Off Bateman's Bay, on the South Coast, brown kelp is abundant at a depth of 25 fathoms, and supports a molluscan fauna identical with that of the rock pools just below low tide. Incidentally no analogy can be made of these with the giant kelp of the sub-Antarctic, which, while attached to the bottom at depths as great as 60 fathoms, grows upwards to use the light close to the surface.

Further information is wanted as to the distribution of red algae in Port Jackson. Generally considered as occupying a lower depth zone than the brown weeds, they nevertheless do occur in Port Jackson and are found even in the rock pools right up to low-water mark. As far as I am aware, no special study has ever been made of the ecological associations of the red weeds, and here is a large and interesting field for specialized research.

Of pressure there is even less information available about its effect on marine organisms. With free-swimming organisms it must have some effect, though we know certain mammals, such as the whale and some fish, can experience great and rapid changes by passing from one depth to another without ill results. The bottom life is, however, either static or of much slower movement, and any passage from shallow to deep water, or *vice versa*, would be gradual and allow adjustment of internal to external pressure. It is possible, however, that many organisms do not possess this adjustability, and are thus limited to definite depths from this factor alone. This again is a subject capable of long and painstaking research, particularly of an anatomical character.

From the foregoing the following conclusions are tentatively drawn. From light alone no ecological depth zones may be expected within the limits of Port Jackson. Pressure is largely an unknown factor, but except in the case of some individual organisms, is not likely to have a great effect within the small limits of from 0 to 10 fathoms.

Salinity.

The salinity of the sea throughout the world is, within very narrow limits, extremely uniform. Even adjacent to the land, except in certain limited areas, it remains unchanged throughout the year and is unaffected by the flow of fresh water from the land to the sea. The excepted areas are in the estuaries or at the mouths of large rivers, or even small rivers which are liable to heavy flooding, or in polar waters, where the summer melting of the winter floes is apt to make the surface waters much fresher.

It is noticeable that in Port Jackson no streams of any size flow into the harbour, and the whole of the drainage basin is comparatively a very small one. The bulk of the drainage of the coastal plain actually flows west to the Hawkesbury River, which finds its outlet in Broken Bay, while a little to the south the George's River empties into Port Hacking.

Actual figures of salinity, again provided by the Maritime Services Board, and taken from one foot below the surface at Port Macquarie, show that in the year from the 31st May, 1943, to 27th May, 1944, the salinity varied from 29·3 to 35·8 grammes per kilo. The lower figure was reached after a period of exceptionally heavy rainfall, and may be taken as extreme, though probably near the outlet of some of the creeks or storm-water channels it would be even lower. No figures are available for deeper water, but it can be taken that as fresh-water is much lighter than salt-water, surface waters are much more quickly affected, and as diffusion is not very rapid, changes in the deeper water are within much smaller limits. Another factor is that the growth of a large city greatly facilitates the run-off after heavy rain. Bare streets, the roofs of houses, and numerous graded storm-water channels ensure that practically all rain falling within the city area reaches the harbour very rapidly, spreads over the surface and reduces salinity. Previously, the forests covering the slopes filtered the rainfall and slowed down the flow of surface water, of which much was absorbed by the porous sandy soil and the sandstone itself. It can be taken that what changes of salinity occur at the present time are partly artificial, induced by city growth, that even now they are largely confined to a foot or two of surface water, and that in the past they were much less.

Most marine organisms are extremely susceptible to any reduction in the salinity of sea-water, and rapidly succumb if it is carried beyond a certain point. It is interesting to compare the extreme richness of the Port Jackson fauna, for instance, with that of the estuary of the Clarence River on the North Coast. Here conditions are ideal for a rich fauna for perhaps 99 per cent of the year, but the Clarence is liable to periodical very heavy flooding and marine life can never get established. Miles of sand and mud flats bordered by mangroves are practically devoid of marine life, save a few hardy molluscs, crabs and worms, whereas comparable flats in Middle Harbour, Port Jackson, or Gunnamatta Bay, Port Hacking, literally teem with marine life of a multitude of species.

The richness of the Port Jackson fauna is further accentuated by the stability of this condition through a very long period. In fact there is no evidence of any change since the actual flooding of the harbour at the close of the last Glacial Period some 10,000 years ago.

Food and Protection.

Food supplies are an essential factor in the distribution of all life. Plants are, of course, the basic substance of all animal life, either directly for vegetable feeders or indirectly for carnivora, scavengers or parasites. In the sea, plant life as food may be considered under two heads—the static, consisting mainly of the larger algae, and the transient, which includes floating algae, mostly microscopic but sometimes large, and diatoms, which are minute. Diatoms exist in infinite numbers in all parts of the world and form an essential constituent of plankton, of which they are the basic food. Plankton itself, consisting of a whole host of organisms, including larvae of crustacea and other groups, forms the food of larger organisms and governs their distribution. Plankton also forms the food of many static creatures inhabiting the sea bottom, and its abundance or scarcity determines their existence.

Apart from the plant life of plankton, however, the larger fixed algae commence a life cycle of their own. Many creatures, large and small, feed

directly upon them, and their distribution is limited to the same areas. Only in some cases, where a free-swimming larval stage occurs, will these creatures depend during part of their life on the floating plant life. Drifting away on ocean currents, when this period of their life cycle is completed, they must find another environment similar to the static one of their parents, or perish. For the great majority of creatures migration must be either by crawling or by swimming very short distances and must of course be much slower. For this reason their geographic distribution is likely to be much more limited, a fact which is well seen in the ecology of oceanic as distinct from continental islands.

Thus while plankton is the predominating factor in the distribution of life in the great masses of the ocean, static algae become of increasing importance adjacent to the coast, in the sheltered waters of bays, and may even become the predominant or only factor. An additional source of food will also be found in these locations by the decomposition of the algae themselves or from the decomposition of organic matter, plant and animal, washed into the sea from the neighbouring land.

In narrow, rather shallow waters, like Port Jackson, there is no evidence of the relative abundance of plankton in depth. Sessile creatures, which live by the absorption of sea-water and the extraction of any organic matter it may contain, are equally abundant in both shallow and deeper water, which would suggest that this organic matter, plankton or otherwise, is fairly equally distributed throughout. In other words, depth zones based on the factor of food are not likely to be defined.

With the static algae, also, looked on purely as a source of food, it has already been pointed out that their distribution is not limited to any depth within the harbour, and thus is not likely to contribute to the formation of faunal depth zones. On this point one vast field of research does remain untouched. This is the question as to whether marine vegetable feeders are selective of their food and to what extent. On the land we know animals are highly selective, but land plants include a great number of natural orders and have a much more diverse chemical composition than have the plants of the sea. Nevertheless, it is of the utmost interest to ascertain if each species of algae supports its own species of herbivorous animals, so that these with other associated species may thus form distinctive ecological colonies.

There remains the factor of protection. All animals and plants develop protection—protection against their physical environment and from their enemies. They do this or perish. This has already been outlined in the introduction to Part 1 of this paper, nor will these problems differ greatly in Port Jackson from similar problems in other marine locations. Protection in animals is, however, a vast and complicated subject, and in any individual species could form the basis of a lifetime's or many lifetimes' research. It covers not only the more obvious things, such as protective colouring, defensive or offensive weapons and speed of movement, but many things less apparent—resistance to disease, fecundity, adaptation to change and other factors more subtle but no less potent. Protection also implies shelter, and here the nature of the environment is all important. This will be dealt with in more detail in the next section—that dealing with the nature of the sea bottom, which it is claimed is the chief factor in determining the limits of ecological communities within the sea.

Ocean and Tidal Currents.

Ocean currents affect the distribution of sea life in several ways. They have a distinct influence on the temperature of sea-water; they transport the larval forms of many species; and they carry food in the form of plankton to the stationary animals. Tidal currents are more local in their consequences; they

have little effect on temperatures. As a means of transport they aid in a limited distribution of various species, but they are very important in carrying planktonic food to many creatures.

Ocean currents have more effect on the outer coast than in enclosed harbours with only one entrance, the waters of which are but little influenced by their passage. Thus in studying the effect of the two main currents on the New South Wales coast, their influence within the enclosed waters of Port Jackson will be slight, except in areas adjacent to the Heads.

The first of these two currents is the Notonectian Current, which flows rapidly from outside the Barrier Reef on the Queensland coast southwards as far as Shellharbour, about 60 miles south of Sydney. It is a warm surface current, and has a distinct effect on the temperature, not only of the sea, but of the coastal areas of the land. It flows throughout the year, but its rate varies at times, and may be at its maximum near the shore or at some distance from the land. It brings with it an endless stream of flotsam from the tropics, including the eggs and larval forms of many tropical marine animals. These are continually settling and growing on the coast, their proportion naturally increasing as we go north. Often, however, they find the new environment unsuitable, or the competition of established species too strong, and they soon die out. Some get a precarious footing, which they barely maintain; only a comparative few become adapted and fit in with new ecological associations. Only rarely do such animals become so firmly established that they oust and replace the original fauna. They remain, at the most, chance visitors, which add to the variety but do not modify the local balance of life.

The limit of distribution of these tropical animals is about 60 miles south of Sydney, and a number, including many molluscs, has been found just within Port Jackson, notably in the vicinity of Watson Bay and Bottle and Glass Rocks. A few molluscs, such as *Strombus* spp. and *Cypraea* spp., are more or less established, but they never form a conspicuous or important element in the fauna.

A cold current from the Antarctic, in contrast to the warm Notonectian current, is also present on the coast. It flows from the south along the eastern shore of Tasmania, across the Bass Strait, up the New South Wales coast, but loses its influence in the vicinity of Sydney. Where the two currents meet, as cold water is heavier than warm, the cold current tends to pass beneath the other and to be diverted into deeper water away from the coast. When speaking of the effect of temperature on marine life, it was pointed out that the minimum extreme is more important in limiting distribution than the maximum. Hence northerly migrating species of animals would be better fitted to withstand sudden changes in temperature caused by the warring of the two currents than would tropical species moving southwards. They would thus much more easily become firmly established. This is evidently the case, for not only do many typical Tasmanian species appear on the New South Wales coast, but they exist in large numbers and have come to form an integral part of the fauna.

Nature of the Sea Bottom.

Reviewing the several factors already discussed, the view is advanced that while they are of the utmost importance in controlling the general distribution of sea life, their effect is regional rather than local. In other words, in a body of water of the limited size and depth of Port Jackson, they are practically constant throughout and have little effect on ecological segregation.

There remains one factor to be considered—the changing nature of the sea bottom—and it is claimed that this is the most important in any attempted classification of habitats. In the introduction to the first part of this paper it was suggested that a useful classification of the sea bottom was as follows:

(*A*) Rock, (*B*) Coral, (*C*) Sand, (*D*) Sandy Mud, (*E*) Mud, (*F*) Weed. This classification is capable of further subdivision according to species of coral, different kinds of rock, sand, mud or weed, and in the great depths of the ocean the various types of ooze, diatomaceous, radiolarian, foraminiferal, or magnetic dust. In Port Jackson, however, there is geological uniformity, the rock is sandstone with a very little shale, the sand consists of water-worn grains of quartz derived from the sandstone, the mud is argillaceous and there are no coral reefs. Apart from coral, therefore, all types of habitat exist, they are uniform throughout, and within their limits they are inhabited by distinctive biological communities which differ considerably from each other. This does not mean that the various species are distributed equally throughout each type of habitat. There will be much localization. Different ecological associations will exist in different places, even though conditions are similar. The chance introduction of one species to a new location may lead to its adaptation to and absorption into new associations, or it may attract to itself its former associations and form a similar community to the one from which it was derived.

But most of the communities within the one type of habitat will have something in common, something which adapts them to that particular habitat and makes them unsuitable for a different one.

Rock.—Except in the uppermost reaches of the Parramatta River, Port Jackson is everywhere flanked by cliffs or bluffs of Hawkesbury sandstone, relieved by occasional beaches. The term river, by the way, is misapplied to what is really but an arm of the harbour. The shores are precipitous and for the most part slope steeply to the nearly level bottom of the harbour. Owing to sedimentation, the rocky fringe is a narrow zone adjacent to the shore, and only in a few places does a rocky platform of moderate area form the sea bottom. There are few reefs away from the shore, the most noteworthy being Sow and Pigs Reef, which divides the harbour not far from the entrance. The shores of the few small islands are similar to those of the mainland. (Fig. 1.)

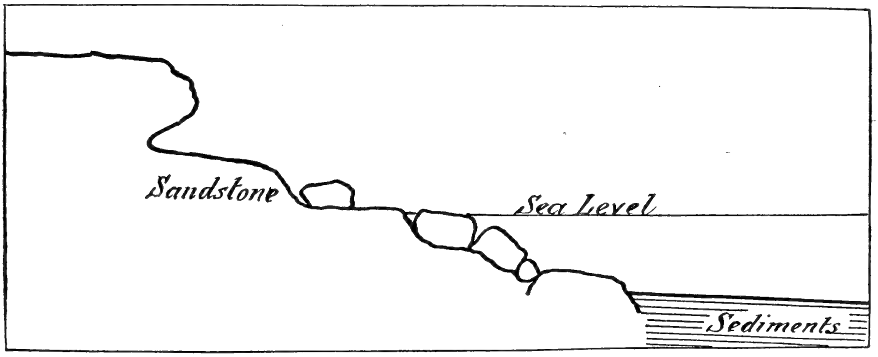

Fig. 1. Diagrammatic section of shore, Port Jackson, showing typical narrow rock zone.

The average depth of this rock zone is about 30 feet, that is from low water to where it is replaced by the sediment that forms the main floor of the harbour. For the most part the water is quiet and only in that area immediately opposite the heads is it exposed to violent wave action. Even here the numerous fallen blocks of sandstone afford abundant shelter for innumerable organisms. Generally the rock is covered by a dense growth of algae, large species of brown kelp predominating. This algal zone will be later considered as forming a distinct

habitat, but apart from its own faunal characteristics, it forms a cover and additional shelter for life typical of the medium on which it grows.

The life of the rock zone is exceedingly rich, both in species and individuals, though difficulty of access makes its specialized study very difficult. Basically there are the static algae as a food constituent, supplemented by a mass of planktonic life carried on the tidal currents. Clear water, ample shelter and food and uniformity of conditions all contribute to the wealth of life.

Without attempting to list the many organisms found here, some general features may be pointed out as characteristic of reef life. There is a high proportion of sessile animals, sponges, actinozoa, serpulae, polyzoa, ascidians, brachiopods, many bivalves and even some gasteropods. All these creatures remain attached throughout the greater part of their existence, and many have distinctive ecological associations. Animals able to adhere to the rock by suction are common. Among these are the star limpet (*Patella perplexa*), other gasteropods such as *Haliotis*, chitons, and many star fish. Large strong-shelled gasteropods are common and some of these are strongly operculate, such as *Turbo*. Rugose and spinose forms abound. Such gasteropods as *Murex* are typical, as are the pelecypods *Spondylus*, *Chama* and *Chlamys*, while the echinoids are nearly all thick-spined species. Colours are generally dark, deep reds and browns predominating.

It is among the sessile animals, or those capable only of slow motion, that the most characteristic reef forms are to be found. Active, rapidly moving animals are largely carnivorous, and though some of them are peculiar to the reef, others are found in many different environments. Carnivora, unless highly specialized to the pursuit of one type of victim, follow their prey into many places. For instance, the boring whelk, *Xymene hanleyi*, is ubiquitous throughout the harbour from between tide marks to the greatest depth, on rock, weed or sand, and even to depths of 60 fathoms on the continental shelf.

Linked with the rock zone within Port Jackson is a much more extensive area of reef fringing the outer coast. Particularly to the north of Sydney and extending right up the coast is a wide platform of rock forming the bottom many miles seawards, from a depth of a few fathoms to 20 or more. As a bridge linking the Queensland and New South Wales coast, these reefs have no doubt allowed the migration of slow-moving tropical forms as far as Sydney and even farther south. These species have a different significance from those which are free swimming, or have a free-swimming larval stage, whose southern migration, borne on the warm Notonectian current, is comparatively rapid.

Unfortunately this outer reef zone is, zoologically speaking, practically unexplored. Too rough for dredging, it is also avoided by trawlers, and all we know of it is from a few creatures thrown on the shore after heavy storms, or from occasional dredging in the sandy patches between the reefs. Such a dredging in 14 fathoms off Long Reef by my son John and myself some years ago, was extremely tantalizing in the mere glimpse it gave of the extreme richness of this area. Its study is a vast field for the future and will need much expensive equipment and elaborate organization before its zoological mysteries are revealed.

Sand.—In striking contrast to rock as an environment is that of sand. By sand is meant a practically pure accumulation of water-worn quartz grains with no admixture of argillaceous or muddy matter. It varies somewhat in coarseness but can be remarkably constant over a considerable distance. Sandy bottoms in Port Jackson are derived mainly by sea erosion of the cliffs forming the shore, and are largely confined to those areas in which wave action is strong and violent. During easterly and south-easterly gales, heavy seas sweep in

between the heads, and a heavy surf penetrates into Middle Harbour as far as Balmoral, and some distance into the west channel adjoining Sow and Pigs Reef. Erosion of the sandstone is comparatively rapid and has produced a sand bottom in the whole of this area. (See map.)

As a rule the surface of the sand is fairly firm, but there is some movement and redistribution of the grains, mostly from the action of tidal currents. This instability, though slight, precludes the growth of fixed algae, removing both shelter and one source of food for animal life. This alone causes a striking dissimilarity between the life of the sand with that of the reef and all other environments. The first thing noticed is the absence of sessile creatures. The few found are small and attached to occasional dead shells. Such is the bivalve *Myochama*, almost invariably attached to another bivalve *Glycymeris*. The gasteropod *Calyptraea*, though free moving, is also found living on larger dead shells.

In the absence of shelter above the surface, many of the animals find refuge below. There is thus a preponderance of burrowers with organs specialized for this purpose. For instance, many of the bivalves have the foot enlarged and strengthened into a burrowing implement, and can often dig or move through the sand with surprising rapidity. Bodies may be greatly elongated, as with worms, or streamlined, as with molluscs. Spines and rough surfaces are a hindrance to rapid passage through the sand, therefore smooth and polished surfaces are an asset. Even the echinoids have soft, short spines, which lie backwards instead of protruding vertically. Typical smooth gasteropods of the sand are *Marginella, Natica, Ancilla, Turritella, Olivella*, and Volutes, while the bivalves include *Glycymeris, Diplodonta, Donax, Macrocallista, Mactra, Tellina* and many others. Bottom-living fish are also highly specialized, generally greatly flattened, either vertically as with the flathead, or laterally as with the soles and flounders.

Colours also are characteristic. There is a predominance of white, but many species develop brilliant red or brown stripes, often zigzagging against a white ground. Such colouring is a good example of disruptive camouflage and is even more effective for concealment than the pure white.

Sand life depends for its food primarily on plankton, and to a lesser extent on dead animal matter sinking to the bottom from the swimming medium above. Life is not so prolific as in most environments, yet compared with, say, the less fertile portions of the earth's surface, it is abundant and varied. Collectively it may be summed up as extremely mobile and active, with a profusion of species as well as individuals scattered fairly uniformly throughout the zone. It forms a wide field for future collecting and research.

Mud and Sand.—Even a small percentage of mud mixed with the sand produces a striking change in environment. Firstly the colour changes and the dazzling white of the sand is replaced by greys, deepening to almost black, according to the amount of mud present. The bottom becomes firmer and more stable, there is little redistribution of sediment, and many of the larger algae can find a secure anchorage. The mud itself, derived in part from the clayey cement of the eroded sandstone, also contains a varying amount of decomposed vegetable matter from the land. This supplies an additional source of food; in fact many animals, including a number of worms, live directly upon it, swallowing it and absorbing the contained organic material.

In Port Jackson, once the turbulent water near the entrance is passed, mud and sand is the prevailing bottom. Biologically it is an intermediate medium, with few characteristics of its own, but sharing more with the reef on one side, with sand on the other, as well as with the pure mud bottom, which will be

dealt with separately. It is, as it were, the meeting place of all faunas, and is the most prolific, both for mass and variety of life. There is abundance of food, uniformity of conditions, and shelter is provided not only beneath the growth of algae, but by burrowing as well. Sessile creatures are abundant, though not as abundant as on the reef, and these are supplemented by others, which, while not actually attached, are embedded and remain practically stationary throughout life. These animals, including many bivalves, are largely siphonate, the siphons may be greatly elongated, enabling the animal to remain buried at a considerable depth and yet retain communication with the surface. The razor shell, *Solen*, is an example of these. This mollusc has a powerful digging foot, by which it is able to rise or bury itself deeper as required.

There is no general characterization of form, as rugose and spiny forms abound in close association with the smooth. Colour is also diverse, but perhaps monochromatic neutral tints; greys, grey-browns and yellow-browns may be considered as typical.

Amongst minute life the foraminifera are often exceedingly abundant. This has been noticed within Port Jackson, but even more so in fine muddy sand from the continental shelf. Here at times they are so abundant as to constitute a very important element of the whole fauna. Much work, however, remains to be done before even the numerous species are determined, to say nothing of their ecological associations.

So far, the sand and mud bottom has been considered as a whole, but this environment, more than the others, is capable of considerable horizontal subdivision. In the absence of sufficient data such a subdivision is not attempted here, but it may be said that it depends primarily on certain local conditions. There is, for instance, considerable difference between the faunas of the Sow and Pigs Reef, which is for the most part a sand and mud bank in close proximity to the open ocean, and the quiet still reaches of Middle Harbour above The Spit. Some indications of the conditions at specific localities are given in the map (Fig. 2), such localities being numbered and brief notes appended.

Mud.—The difference between a pure muddy bottom and one of mud and sand depends largely on its physical consistency. Where the mud is well packed the surface is firm and there is not a great deal of difference. There is the same abundant growth of algae, much the same proportion of sessile, burrowing and crawling creatures, with the same general characteristics. Where the mud, however, retains a high content of water and remains soft and incoherent, quite a different environment is created.

Areas of pure mud occur naturally in many of the upper parts of Port Jackson, in Middle Harbour, in the Lane Cove River and in Parramatta River. In the main part of the harbour, immediately west of Bradley's Head, the bottom is composed of a very soft mud, which fills Athol Bight, Mosman Bay and other inlets. It is quite probable, however, that much of this mud is of very recent origin, derived from drainage from the adjacent built-on areas.

Such deposits, consisting of city dust, dust worn from metalled or concrete roads, can be very deleterious to local marine life, particularly if it is mixed with oily matter. It has been noticed that in dredgings in Athol Bight and Mosman Bay, though many dead shells are procured, there is a very small proportion of living molluscs and other organisms. Oil on the foreshores has also destroyed much of what was formerly a rich marine fauna.

In the quieter reaches of Middle Harbour, where the shores are still covered with virgin forest, areas of mud are still in their original natural condition, with their fauna intact. These mud bottoms often adjoin mangrove swamps, with which they have some affinity, but in Port Jackson, Pittwater, Port Hacking

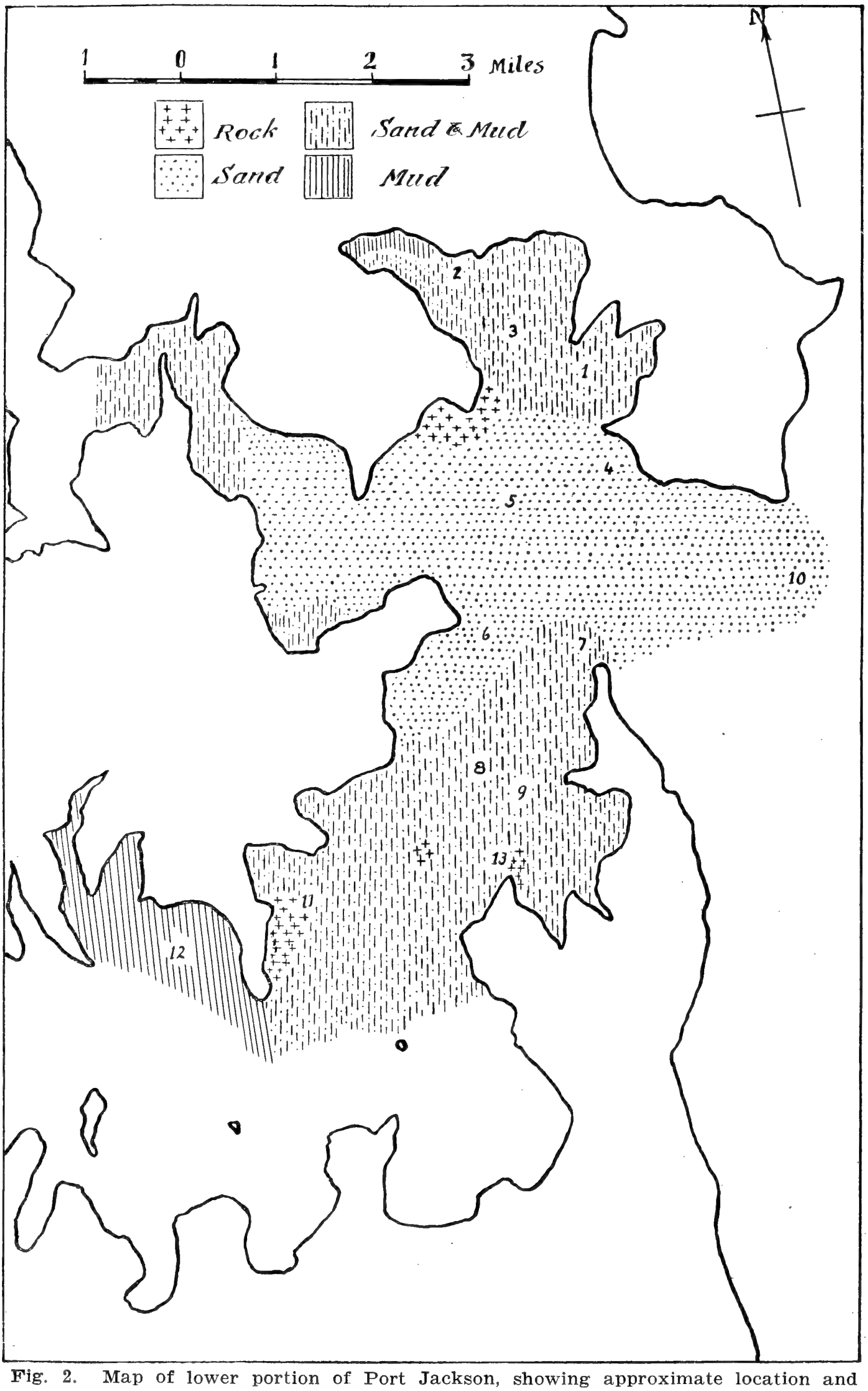

Fig. 2. Map of lower portion of Port Jackson, showing approximate location and extent of the varying types of sea bottom. Notes on numbered locations appear below.

and other localities where salinity is not affected by rivers, the fauna is not estuarine in character, but essentially marine.

As a habitat, mud has some essential differences from others. The soft nature of the mud makes it practically a swimming medium, in which only specialized forms can exist. Sessile animals are practically absent and crawling animals have broad ventral surfaces. There is a penalty on weight, as animals have to support themselves on the soft surface or by practically swimming

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1. Quarantine Bay, depth 30-40 feet. Bottom mud and sand with heavy growth of algae. Marine life exceedingly rich, an interesting feature being the appearance of many molluscs typical of deeper water on the continental shelf. Among these are *Cardium pulchellum* (very abundant), *Modiolus arborescens* and some of the Turridae. The otherwise rare bivalve *Cuspidaria brazieri* is here very common.

2. North Harbour, depth 20 feet. Bottom mud and sand with a fairly high proportion of mud. Life abundant, the bivalve *Corbula* being conspicuous.

3. North Harbour, depth 30 feet. Bottom mud and sand, growth of algae heavy. Life rich. In shallower water nearer the western shore the bottom is sandier and typical sand forms appear, notably the molluscs *Natica sagittata* and *Ancilla*.

4. Depth 60 feet, bottom coarse sand, much disturbed by tidal currents. Life rather sparse, but typical sand bivalves occur, such as *Glycymeris*, with gasteropods such as *Turritella* and *Marginella*, and many short-spined echinoids.

5. Depth 60-70 feet, bottom sand, but finer than at 4. The usual typical sand fauna occurs. This type of bottom extends right into Middle Harbour, but becomes shallower. There is a patch of mud and sand off the southern end of Balmoral Beach.

6. West Channel, Sow and Pigs Reef, originally shallow, but now dredged to over 40 feet. Bottom fine sand, extending well into the channel. The extreme richness of the fauna here has been revealed by recent dredging by the harbour dredge "Triton". Though most of the material is dead, consisting largely of the shells of molluscs, a great variety of typical sand-living forms have been noted, including such continental shelf species as *Marginella kemblensis, Olivella exquisita, Terebra* spp. and many others.

7. Depth 40-50 feet. The area of mud and sand, forming the bank of Sow and Pigs, here extends right round South Head. It is generally a rich dredging area, with many deep-water species appearing.

8. Sow and Pigs Reef. For the most part a bank of mud and sand, with rocky reefs appearing in several places at or near the surface. The water is shallow, averaging about 20 feet. There is a heavy growth of algae over most of the bank and life is exceedingly rich. It is a famous collecting locality.

9. East Channel, Sow and Pigs Reef, originally shallow, but deepened to over 40 feet by dredging. About 20 years ago, when the "Triton" was dredging in this locality, much of the material was used for reclaiming land at Dundas on the Parramatta River. It was thus available for examination and yielded amongst the more familiar species many curious and large tropical shells of types which seem to be now extinct in Port Jackson. Such genera as *Distortio*, several species of *Strombus* and others were amongst those found. (Iredale, 1929.)

10. Depth 120-130 feet. Bottom pure sand, with typical sand fauna, the proportion of continental shelf species increasing as the waters of the harbour give place to those of the open ocean.

11. Off Bradley's Head, depth 30-40 feet. This is one of the few localiites where a rocky shelf persists some distance from the shore. There is a heavy growth of algae, and probably a very rich marine life, but the bottom is too rough, and attempts to dredge met with failure.

12. Athol Bight, depth 50-60 feet. Bottom very soft mud, probably of late origin, with comparatively little life at the present time.

13. Bottle and Glass Rocks. A rich shore-collecting locality. Immediately offshore there is a rough rocky bottom, which can be seen clearly through a depth of up to 20 feet. Life must there be very rich, and enormous numbers of large-spined echinoids are visible. A chance dredging in a patch between rocks contained many species, including two live *Ovula*.

through the mud. Molluscs have generally thin and fragile shells. Such bivalves as *Anatina* and some of the Tellinids are characteristic, though, curiously enough, *Nucula*, a smooth but rather heavy shell, is typical of a real mud bottom.

At first sight, though the mud fauna seems rather limited, it is really a fairly comprehensive one and has not had the attention it deserves. It provides an extensive field for further research.

Weed.—Though the algae growing on rock or on sand and mud partially share the fauna of these mediums, they have a distinctive life and thus may be defined as a definite habitat. Here research is still in its initial stages. One question already raised is whether each species of algae has its own distinct faunal associations as have so many terrestrial plants. This question as yet cannot be answered, but is well worthy of detailed investigation.

Basically the fauna of the algae is small, often minute. A few larger animals—that is, larger comparatively—live on the larger species of kelp, but generally, even with the support of the surrounding medium of sea-water, size and weight are characters unsuitable to the environment. Many minute organisms live directly upon the 'hairs' of the algae, and these in turn have a host of enemies which prey upon them. The few sessile animals are also small, and of these, serpulid worms and polyzoa are the commonest. These live on microscopic organisms in the water itself, and not on the algae, which they use merely as a base.

Among the direct vegetable feeders are many minute gasteropods, notably among the Rissoidae, Liotiidae, Trochidae and other families. One whole group of gasteropods, not unlike some land shells in appearance, are probably the smallest in the world, many of them below 0·5 mm. across, and they are as yet entirely undescribed. It is interesting to note that two rather larger, typical weed-living gasteropods, *Phasianella perdix* and *Cantharidus eximinus*, are equally abundant in rock pools at low tide and in depths of over 25 fathoms off Bateman's Bay.

Equally abundant with the molluscs are innumerable small crustaceans, amongst which are many arthropods, copepods and isopods; also many small stars and brittle stars, worms and other animals are to be found.

Form is exceedingly variable, but colours are generally a uniform dark brown, making many of the creatures practically invisible against their background. A casual examination of the algae, even with a lens, reveals practically nothing of the wealth of life. If a quantity, however, be placed in a bucket of fresh-water, the animals are killed and become detached, and a study of the resulting debris reveals them in all their wealth of numbers and species. So great is this that almost any such washing is bound to bring to light new and undescribed species, and here is a field of vast extent for future research.

Origin of the Port Jackson Fauna.

It is with some temerity that the question of the origin of the Port Jackson fauna is introduced. Actually little more can be done than state it as a problem for future research. The problem is a world-wide one, the first stage in its investigation being the division of the world's surface into Zoo-geographical Regions, and the further sub-division of these into Provinces. The all-important question to be answered is: "Does this division extend backwards into the past and, if so, how far back do the present geographical boundaries persist?" There is unfortunately little information on this question, and such that exists is fragmentary and scattered.

Comparison between existing faunas and fossil faunas from the same or adjacent areas is obviously the first line of approach. For certain areas this is

to some extent possible, but even then a complete picture of the life of any period can never be made. Only the hard parts of organisms, and of these only the merest fraction, have been preserved. All traces of soft-bodied creatures have entirely disappeared. The sequence of formation has been frequently interrupted and the details of contemporary topography are generally obscure.

In Australia, the Tertiary marine beds of South Australia, Victoria and northern Tasmania afford some comparison with the existing fauna. But these beds are limited in extent, their correlation in time is far from complete, and any generalization at this stage would be premature. In New Zealand, also, some work has been done and an attempt made to trace the genetics of the Volutes from present times back to the Tertiary.

But what of the tropical fauna? Is it older or newer than that of the adjoining temperate and cold water faunas, or have they developed uniformly side by side? On the whole of the eastern coast of Australia no marine fossiliferous strata exist newer than Palaeozoic, while in central and northern Australia Cretaceous marine rocks are the most recent. Perhaps New Guinea holds the key? The geological exploration of New Guinea may reveal Tertiary or Post-Tertiary beds of marine origin and, if so, examination of their fossil contents will be of the utmost scientific value.. Comparative anatomy and a study of embryology offer, for the time being, the only other line of approach.

Before leaving the subject one or two points may be mentioned which, while not throwing any particular light on the problem, are suggestive. It is possible that the marine fauna of south-eastern Australia, like that of the land, is very old. *Trigonia*, a common and typical bivalve, was first known as a Mesozoic fossil in Europe, where many species are to be found. As more and more new molluscs come to light from the continental shelf, many are seen to have closer relationship with Australian Tertiary forms than those of adjoining provinces. This relationship probably extends further afield. Without detailing species, a brief glance through the plates illustrating the fossils of the Tertiary basin beneath Paris reveals a general facies which greatly resembles that of the New South Wales fauna. A more detailed comparison might well be worth while.

The whole problem is a difficult one and shows how little we really do know of the marine life of this world of ours.

Conclusion.

I am afraid that this paper has done little more than set out a problem and lay down a tentative plan for future research. An attempt has been made to find solutions for a few of the questions raised, but much information is required before even a partial answer can be made. It is nevertheless felt that some plan, however imperfect, is necessary, if only to give a direction to and co-ordinate much scattered work that is now being done. No doubt details of the plan will be modified, even its main structure altered, as additional facts come to hand.

Of conclusions here reached, the main one is that faunal zoning in depth in Port Jackson does not continue below extreme low tide. Faunal depth zones are of considerably greater vertical magnitude than comes within the whole range of depth in the harbour. The zoning of the harbour bed is therefore horizontal rather than vertical, and the varying nature of the sea bottom is the main factor governing the distribution of life and the segregation of ecological communities.

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"LOVE'S MEINIE."

By Tom Iredale.

"I see this book was begun eight years ago; . . . then intended to contain only four Oxford lectures: but the said lectures also 'intended' to contain the cream of forty volumes of scientific ornithology." Such a statement could only have been written by a supreme egotist, a professional critic unaware of his stupendous ignorance, emphasized a couple of pages later with "Thoughtless readers, who imagine that my own style (such as it is, the one thing which the British public concedes to me as a real power) has been formed without pains, may smile at the confidence with which I speak of altering accepted, and even long-established nomenclature". It is somewhat difficult to visualize the self-importance of such an individual, especially in view of the complete (and more complete it could not have been) failure of this particular project. The "lectures", only three in number, form Volume I, dated 1881, of "Love's Meinie. Lectures on Greek and English Birds", and total the beginning and end of the ill-fated attempt at "altering accepted, and even long-established nomenclature". The lectures are written "in a manner suited for oral delivery, and imagine myself speaking to my pupils". The first lecture is entitled "The Robin" and is worth reading as the perfect example of how not to write the natural history of birds "but by a scholar and a gentleman". The pretentiousness is almost stifling and sickening, though analysing the essay as wished, it is possible to get information out of it, though not all of it trustworthy, and the best part is that wherein the subject is left forlorn and meanderings erstwhile occupy the writer.

Thus, "Lord Derby is the first to propose that wood birds should have no more nests. We must cut down all our trees, he says, that we may effectively use the steam-plough; and the effect of the steam-plough, I find by a recent article in the 'Cornhill Magazine', is that an English labourer must not any more have a nest, nor bantlings [babies] neither; but may only expect to get on prosperously in life, if he be perfectly skilful, sober, and honest, and dispenses, at least until he is forty-five, with the luxury of marriage."

Then came the Swallow. "I have said that I never get into scrapes by blaming people wrongly; but I often do by praising them wrongly. I never praised, without qualification, but one scientific book in my life (that I remember) . . . this of Dr. Pettigrew's on the wing." So he shows that he was incorrect in his praise and develops an essay on flight which is worth the opening of the book. With this essay the Swallow is not much concerned save as a peg.

The third lecture is the Dabchicks, but facing it is a page (84) with names of the birds noticed in the following lecture.

I.	*Merula Fontium.*	Torrent Ouzel	Text Page	94,	Appendix Page	180
II.	*Allegretta Nymphaea.*	Lily Ouzel	,,	99,	,,	180
IIA.	*Allegretta Maculata.*	Spotted Allegret ..	,,	102	,,	182
IIB.	*Allegretta Stellaris.*	Starry Allegret ..	,,	103	,,	183
IIC.	*Allegretta Minuta.*	Tiny Allegret	,,	104	,,	184
III.	*Trepida Stagnarum.*	Little Grebe	,,	107	,,	185
IV.	*Titania Arctica.*	Arctic Fairy	,,	119,	,,	186
IVB.	*Titania Inconstans.*	Changeful Fairy ..	,,	124	,,	188
V.	*Rallus Aquaticus.*	Water Rail	,,	128	,,	188
VI.	*Pulla Aquatica.*	Water Hen	,,	133	,,	190

Then in the Appendix, added after the third lecture, some more names are given:

Page 171. *Rutila familiaris* for *Motacilla rubecula* L.
172. *Hirundo domestica* for *Hirundo rustica* L.
172. *Hirundo monastica* for *Hirundo urbica* L.
175. *Hirundo sagitta* for *Hirundo apus* L.
177. *Hirundo alpina* for *Hirundo melba* L.
178. *Noctua europaea* for *Caprimulgus europeus* L.

None of these names has been cited in synonymy of birds, but it appears they are lawfully introduced whatever the grotesque reasons for their proposition. Fortunately, none is valid for usage in any connection, as might be gathered from the absurd associations suggested.

Now, who wrote these absurdities? It will certainly surprise most ornithological students, as it did the present writer when Mr. G. P. Whitley brought the book to his notice: JOHN RUSKIN, great critic of the Victorian age, was responsible. After consideration, reference was made to an Encyclopaedia, which stated that Ruskin had written it when he was sixty-two and planned more, but it was found that he lived nearly twenty years longer and that "His judgments on subjects other than art were frequently hasty and prejudiced. He suffered during his later years from mental strain and occasional fits of insanity". Perhaps these efforts were the early signs of instability, as, while there are lots of interesting data (all taken from books), there are also lots of useless, inconsequent interpellations. Ruskin mentioned, "I have called . . . 'the scurviest louts that ever fouled God's earth with their carcasses'. The language appears to be violent. It is simply brief and accurate." The essays might be mentioned in language which might be called violent, but which would be brief and accurate, but it will be unnecessary to write it. The complete ignoring and forgetting every word in the book is sufficient condemnation. But as the book has been forgotten it is possibly scarce, and so a few remarks upon the names may be given as a warning to non-ornithological critics to stick to their lasts and leave alone matters they don't understand—save that a critic would respond that there is nothing he doesn't understand. "Love's Meinie" is a curious attempt to suggest names for birds without any bird knowledge, as obviously he knew very little, and nearly the whole of the comments are based upon pictures which he despised for their artistic insufficiencies.

But enough, just look at his Dabchicks. First, the Torrent Ouzel (now known as the Dipper), then the Little Crakes, which he calls Allegrets, followed by the Little Grebe, then the Phalaropes, which he calls Fairies, concluding with the Water Rail and Water Hen, then switching on to a peroration occupying fifteen pages dealing with modern painters, "scurvy louts", carthorses, etc. It sounds like the ramblings of a madman, and probably that is why the book has been ignored, not a valid reason, as quite a few scientists whose work is admired and utilized were also found to be more or less insane. It would be difficult to pick out the valuable parts of the book, and probably these have all been taken from someone else, so that the book may be derided but it can never be forgotten by anyone who looks at it.

The only comment noted (by Mullens) reads: "As for the ornithological knowledge displayed therein the less said the better, always supposing his remarks are serious." But it is well known that Ruskin was always serious and it was this lack of humour that caused his mental instability in his later years.

It had better be stated what Ruskin's new names refer to, as they are bibliographically determined by reference to authorities, thus:

Allegretta nymphaea = Spotted Crakes.
Allegretta maculata = *Rallus porzana* L.
Allegretta stellaris = *Crex baillonii* Yarrell.
Allegretta minuta = *Porzana minuta* Gould.
Trepida stagnarum = *Colymbus minor* L.
Titania arctica = *Tringa fulicaria* L. = *Lobipes hyperboreus* Gould.
Titania inconstans = *Tringa lobata* L. = *Phalaropus fulicarius* Gould.
Pulla aquatica = *Gallinula chloropus* Gould.

"Note there is no proper feminine of 'pullus', and I use the adjective 'pulla' to express the dark colour." He admits to having fifteen volumes of ornithology, an ample number, referring first to one and then to the other, commonly ridiculing the information provided.

The curious title, "Love's Meinie", refers to birds themselves. "'Meinie' is the old English word for 'many', in the sense of 'a many' persons attending one, as bridesmaids, when in sixes or tens or dozens."

REVIEW.

NATIVE ANIMALS OF NEW ZEALAND. By A. W. B. Powell, Auckland Museum Handbook of Zoology, published 19th August, 1947, pp. 1-96, figs. 1-411. Price: 6s. (postage 3d.).

The Auckland Museum is to be congratulated on bringing out this attractively produced, modern guide to the animals of New Zealand, covering as it does not only the lowest forms like sponges, worms, molluscs and other invertebrates, but fishes, reptiles, birds, and mammals.

The clear, bold drawings, made by the author, enable easy identification of the species, each of which is dealt with in a popular manner. A list of works for reference affords a key for the student who wishes to delve more deeply into any animal group.

New Zealand, we are told, has been separated from other lands for more than sixty million years. Thus, apart from bats, there are no native land mammals, and some of the birds were able to forage on the ground, leading to heavier build and reduced wings (kiwis and extinct moas).

The Tuatara, amongst reptiles, is the sole survivor of a group which became extinct elsewhere many millions of years ago.

A century of cultivation and acclimatization has upset the balance of primeval nature, causing immense changes in the native New Zealand land fauna, some species having been extinguished and others sadly reduced. This destruction has extended to some marine animals, seals in particular having suffered depredation.

Mr. Powell's handbook can be highly recommended to all naturalists.—ED.

THE BIOLOGY OF AN AUSTRALIAN MANTISPID (*MANTISPA VITTATA* GUÉRIN).

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(Plates xiv–xv, text-figs. 1–13.)

Up till the present, entomologists and arachnologists have paid little attention to the life history, habits and behaviour of the Mantispidae, that remarkable group of Neuropterous spider parasites. Published accounts from Europe, America and Japan are in every instance fragmentary and often contradictory in their details. The classical investigations of Brauer (1869) were for long the only source of information, and all the standard entomological text-books gave Brauer's account as typical for the group. Subsequent work has added little to our knowledge. In no instance was anything known concerning the life of any Australian species.

This paper, the result of friendly collaboration between two widely separated workers, McKeown, of Sydney, and Mincham, of Hammond, South Australia (then stationed at Willalo, in the same State) should go far towards presenting a complete account of the life history and habits of these strange insects and filling many gaps in our knowledge.

Mantispa vittata Guérin, 1837.

(Plates xiv–xv, figs. 1–4, 8–10; text-figs. 1–6.)

Mantispa vittata, one of the largest and most widely distributed of the Australian species, was originally described by Guérin-Meneville, 1837, but is better known from his account published in 1838 (*Voyage Autour du Monde sur . . .* La Coquille . . . 1822-1825, *Zool.*, ii, 2, Div. 1, Chap. xiii, Insectes, p. 196). The species was redescribed in 1852 by J. O. Westwood.

The general appearance of the insect is as shown in text-figure 1. It is five-sixths of an inch long, with an expanse of an inch and a half, and is of a general reddish-brown colour.

Specimens of *Mantispa vittata* have been seen from New South Wales, Victoria, South Australia, and Tasmania.

A Geographical Note.

Before passing on to details of the observations on the biology of *Mantispa vittata* it will be well to give some description of Willalo and its surroundings.

Willalo is a district 120 miles north of Adelaide and lies a few miles west of Hallett, the nearest railway station, comprising farm and station properties situated in a long trough-like valley extending in a more or less north-south direction. This ridge and valley formation is a widespread physiographical feature of the central highlands of South Australia. The crests of the ranges that enclose the valley on each side are about six miles apart. Peaks along the ridges reach, or even slightly exceed, 2,000 feet above sea level. Average rainfall is 17–18 inches per year. The valley floor is filled with a rich, red-brown, clayey loam. Lucerne flourishes in this loam and large areas are under this crop. This means that much of the land lies unploughed and stable for fairly long periods, a factor that apparently favours the development of a large local population of

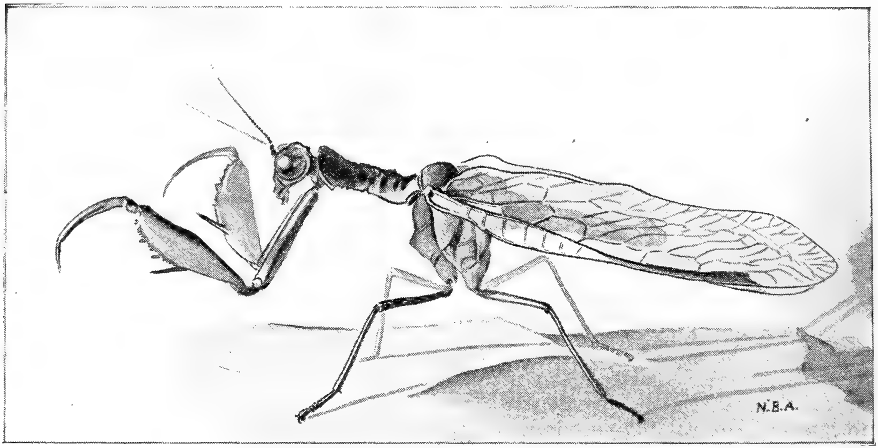


Fig. 1.—*Mantispa vittata* Guérin. (Enlarged.)
N. B. Adams del.

Lycosid spiders. The clayey loam is easily excavated by the spiders following the autumn, winter or spring rains, and its consistency gives a degree of permanency to the spiders' burrows that must be of advantage to them. There is no real sand in the district at all; this probably accounts for the fact that no Neuroptera with pit-forming larvae occur in the area. Antlions (Myrmeliontidae) abound in the sandy country of the arid interior. One enters the margin of this vast region some twenty or thirty miles north of Willalo.

Mantispid Distribution within the District.

An interesting point is the fact that the Mantispids are practically always found near the various isolated clumps of trees in the district. There are more than a dozen eucalypts in the school-yard, some of them nearly 70 feet high. Immediately north of the school a road runs in an east-west direction, while a road from the south intersects this at the school. Consequently roads run east, west, and south from the school, and telephone lines extend along all three. In the autumn of 1946 the telephone poles near the school were well covered with Mantispid eggs. Many eggs, too, were laid on the iron and woodwork of the school building. There are three clumps of eucalypts along the east road, situated at distances of 28, 35, and 70 chains from the school. Poles near all of these were well coated with eggs, but hardly a pole more than three chains from the gums had any eggs at all. The same state of affairs was noted along the other roads, where, at various intervals, clumps of gums occur. One farmer has in his paddock a plantation of gums consisting of about 150 trees. Near by stand two or three dying pine trees, in which the dead branches attracted the laying females. In nearly every instance where large egg masses were found, they were near, or no further than a few chains away from, clumps of trees. It seems probable that the insects upon emerging from the cocoon fly to the trees to feed and mate in the foliage. Later, they apparently quit the trees to oviposit.

Other Neuroptera in the District.

Apart from the numerous individuals of *Mantispa vittata*, the Order Neuroptera is poorly represented. A species of *Chrysopa* is rather common in

summer, while the small brown Hemerobiid, *Micromus tasmaniae* Walk., is sometimes found in grass and was plentiful in the spring of 1946. With one exception, no Myrmeliontidae have been found. The sole exception was the widely distributed *Acanthaclisis fundata* Walk., one specimen being taken. One specimen of a species of *Acmonotus* (Ascalaphidae) has been captured and another observed in flight. If other species of the order occur, they must be extremely rare.

Seasonal Occurrence of Mantispids.

Autumn is the season when Mantispids are chiefly in evidence, though an occasional individual may be seen during most months of the year. They are most abundant in April. Amazing numbers have been noted at times in the district, particularly on several occasions during April, 1946, when as many as fifty females were observed ovipositing on one telegraph pole at the one time.

Some detail on the autumn occurrence of Mantispids during 1947—after Mr. Mincham's transfer to Hammond—have been received from an observer at Willalo. The season was of much briefer duration than the corresponding one of 1946. The Mantispids were, however, for about a fortnight, more numerous than at any time in the 1946 season, which had seemed exceptional from the numerical point of view. The Mantispids were first seen in the first week of March, four on the 21st, sixteen on the 24th, and forty on the 25th. On 26th March, the incredible number of 254 were counted ovipositing on two telegraph poles. These amazing numbers continued until the second week in April and then rapidly declined. No insects were seen at all after April. The insects were mostly ovipositing on poles standing near clumps of Sugar Gums (*Eucalyptus cladocalyx*).

A second Mantispid season occurs in late spring. Mantispids were noted in late October and in November in 1945. In 1946, the first was seen on 25th October. By the end of that month five had been seen. They were found fairly frequently throughout most of November, on the 7th of which the first occurrence of ovipositing was noted. They were never found in the spring season to occur in numbers greater than two or three, and were rare throughout December. The last insect seen in this season was a solitary male found on 1st January, 1947. None was then seen until the following March when, apparently, the new generation began to emerge. These were the forerunners of the autumn season. Throughout April they abounded. They were found in decreasing numbers on occasions in May and were rare in June. The final insect of this long season was seen on 20th June.

Oviposition.

The eggs are usually deposited on the bark of dead pine trees and on telegraph poles. In one instance only has evidence of oviposition upon the green wood of eucalypts been noted; this was on 6th September, 1946, when a green branch was found, ten or eleven feet from the ground, which had obviously been well attended by laying females during the previous autumn. All the eggs had, of course, long since hatched. They had been deposited in an extensive mass to which at least twenty females must have contributed. It is possible that egg-laying may take place high on the tree-trunks, although seldom observed. It is considered that the presence of ants on the tree-trunks may be a disturbing factor in such situations, and tend to discourage oviposition.

A remarkable fact concerning the insects is their pronounced disposition to oviposit on telegraph poles, practically all of which are of iron in the Willalo district. More eggs have been deposited on these than on any other objects, although the iron supporting towers of some windmills have also received a

large deposit of eggs. Some of the insects oviposit upon sheds, where they lay upon the galvanized iron as often as upon the woodwork.

That this habit is not purely a local one, induced by the scarcity of trees, is borne out by the observations of Brauer (1869), Laboulbène (1893), and Poujade (1898); in one instance the eggs were attached to a stone signpost, in another to the bark of an old oak tree, whilst in captivity they were laid on the side of the box or upon plants. Captives, in our experience, always lay on the box in which they are imprisoned.

An even more remarkable fact is the widespread habit of community oviposition, so repeatedly observed at Willalo. Such a habit does not appear to have been recorded elsewhere. R. C. Smith (1934) records that a female of *M. savi* Banks deposited a total of 2,200 eggs in six batches, extending over a period of approximately one month. Hoffmann (1936) states that a single female of *Climaciella brunnea* var. *occidentalis* Banks deposited a total of 1,028 eggs in a single cluster in one day. R. C. Smith says that *C. brunnea* Say, when in confinement, deposits about 250 eggs to each female.

The ovipositing groups of the Australian *Mantispa vittata* have been seen laying in positions on telephone poles varying from near ground level to almost at the top. The largest groups noted comprised the amazing number of 254 upon two poles—already mentioned—in 1947; 50, scattered over a number of groups, in 1946. The maximum in one group comprised 15 individuals, and some of these were so densely crowded that a few females deposited a number of eggs upon the wings and backs of others. As a rule such groups comprise four to eight individuals.

The groups tend to form around a batch of eggs laid earlier by an individual. An individual female of *Mantispa vittata* deposits her eggs in a cluster or patch, depositing from several hundred to more than three thousand at a time. The eggs are laid steadily at the rate of one egg every four to seven seconds. The general rate of egg-laying may be best expressed at a dozen, or upwards of a dozen, per minute.

Some females deposit their eggs over a patch previously laid, adding greatly to the density, but little to the area of the egg mass. Such females lay much more slowly because they have to work their abdominal tips down through eggs already deposited.

The eggs are deposited in rows. In some patches the rows are more or less clearly defined, but often their arrangement is obscured by the density of the egg mass. The eggs are deposited transversely by swinging the abdominal tip alternately from side to side. Each row is begun just in front of the end of the previous one. The tip of the abdomen is brought down onto the surface upon which the eggs are being deposited, and is then raised. By this means the gummy substance of which the egg-stalks are formed is drawn out in a fine thread. This speedily hardens in the air and supports the egg, which remains firmly attached to its extremity. So far as observed, *Mantispa vittata* deposits all her eggs at one time and may spend some hours in the operation. When laying, the Mantispids seem to be largely indifferent to their surroundings. A dwarf may occasionally be seen among her large sisters, adding her eggs to the rapidly growing "super-batch".

In one instance only has a Mantispid been observed to feed while oviposition was in progress. The insect seized a fly and ate it without pausing in her egg-laying.

Oviposition occurs chiefly in autumn, most eggs being deposited in April. In 1946 one female laid as early as 13th March. Several were observed laying as late as 27th May. Variations in temperature may slow up or even cause a temporary cessation of oviposition. In 1946, Mantispids were seen laying up to

the 10th May. Cold weather followed the 10th for a few days. No insects were seen until a week later, and none was observed to lay again until the 23rd May. Several were observed ovipositing on 24th and 25th May, two on the 26th, and one on the 27th.

Considerable time was spent observing the insects ovipositing on the 25th and 26th May. One female took over four hours to complete laying, another a period of over five hours. These two insects were seen to alight on a telegraph pole about midday. They settled some inches from a large egg patch. After remaining still for upwards of a quarter of an hour, they approached the eggs. Once upon the egg-mass they brought their antennae energetically to bear. After tapping the eggs for a while—in a manner reminiscent of that employed by certain Ichneumons on the bark of trees under which longicorn larvae are concealed—the Mantispids began to lay. It would seem that the Mantispids are drawn together, not by the attraction of the insects already present, but by that of the eggs previously deposited. They pay no attention to each other, but are definitely attracted to the eggs. Small flies (*Musca* sp.) were very numerous at the time and several were seen to settle near the females and within easy reach. To these the Mantispids paid not the slightest heed.

The egg-masses formed by communal effort are sometimes of great size and, considering the minute size of the individual egg, must contain vast numbers of eggs (Pl. xiv, fig. 5). The largest found was on a telegraph pole and was almost twenty inches in length. Scores of insects must have contributed to its formation.

The eggs (text-fig. 7) are elongate, cylindrical with rounded ends, and borne upon a short stalk. The egg is about ·5 mm., or about 1/50th of an inch, in length. The egg-stalk averages about $1\frac{1}{2}$ to $2\frac{1}{2}$ times the length of the egg itself. There is, however, great variation; some eggs have been noted with stalks fully four times the egg length. It would appear from observation that the stalks are longest on eggs deposited upon smooth tin or glass; such surfaces would absorb none of the gummy fluid that is drawn out to form the stalks during oviposition. When freshly laid, the eggs are pale salmon-pink or light cream in colour, darkening to a considerable degree as hatching approaches.

The shell of the egg is transparent and, as the time of hatching approaches, certain details of the enclosed embryo become discernible. Under the microscope, the eyes of the larva are clearly visible and the pattern of brown patches on the dorsal surface of the segments is strongly apparent.

The incubation period is variable, fluctuating with the prevailing climatic conditions. Eggs deposited in autumn hatched in from 28 to 40 days; in the warmer weather of November it was found that the eggs hatched within 16 to 18 days. Sixteen days was the minimum and forty the maximum period of incubation noted.

Four batches of eggs, deposited on 25th May, 1946, were kept under close observation, two in the open on telegraph poles and two within the house. Although larvae developed in all these eggs, none emerged, and they were found to be dead. The weather during the period subsequent to the deposition of these eggs was extremely cold. On very few days did the maximum shade temperature reach 60°F., while the maximum for the majority did not attain 60°. Several days showed a registration of less than 50°F. Frosts occurred on most nights. The chances of survival of Mantispid eggs laid in late autumn or early winter would appear to be remote unless mild conditions were experienced.

The Larva, Development and Behaviour.

The larvae on hatching are extremely slender, campodeiform, with a marked pattern of somewhat laterally placed brownish patches on the dorsal surface.

These newly emerged larvae measure slightly more than a millimetre, or about 1/20th of an inch, in length. This measurement is at least 2½ times the length of the egg; consequently the insect is extremely doubled-up within the egg shell prior to emergence. This can be clearly seen in a microscopical examination of the egg before hatching. The appearance of the newly hatched larva is well shown in text-fig. 8.

The earliest of the newly hatched larvae in autumn show little tendency to disperse; those hatched later in the season, none. They simply hibernate. Experiments conducted to breed autumn larvae through to maturity failed in the autumn. Such breeding experiments, however, were successful in late spring with autumn larvae that had hibernated all the winter. The first of the autumn larvae observed in 1946 hatched on 10th April. These did not readily feed, but a small number was induced to. Of these, only one reached the spinning stage. This one, after a prolonged feeding stage compared with that shown in spring development, made a very incomplete cocoon, but died over winter. In captivity, in the security of glass jars and other receptacles, larvae hatching in May and early June cluster together in great masses or may not even leave the egg mass, the stalks and empty shells affording some cover. On the telephone poles it was noticed that many larvae cling in masses to the egg masses for a day or two, but eventually disperse, wind and rain probably contributing largely to their dispersal. Few, it would seem, could long survive in the rain-swept fields in winter, and their survival here probably depends on finding and entering the shaft of some ground-dwelling spider—preferably that of a *Lycosa*. In both seasons only a very small percentage of the larvae can possibly survive, but the death rate among those of the earlier season must be very much higher.

The question as to whether hibernation occurred in the open by massed larvae, so familiar in confinement, was answered when thousands of larvae hibernating in a natural state were found on 20th July, 1946. A few days previously a boy had brought in a piece of a dead limb of a pine tree covered with thousands of hatched eggs; dozens of females had obviously deposited the familiar "super-batch" upon it. When examined in detail, thousands of larvae were found hibernating under the dry bark which adhered to the bough. The bark afforded a snug and secure shelter. They were as densely crowded together as space would permit, but were necessarily spread over a wide area under the bark. This pronounced gregariousness of the larvae is highly remarkable. It is apparent only during hibernation, and this occurs only in cold weather. There must be some survival value in the crowding together of the small larvae in dense masses. These masses of hibernating larvae soon break up and disperse when warmed by the lamp or fire, or when exposed to the warmth of the sun in a sheltered place on a clear day.

After the pine-limb discovery dead branches of sugar gums were searched as thoroughly as possible for similar larval hiding places. One dead limb covered with thousands of hatched eggs was found at a height of about 15 or 16 feet. The bough had very little bark left on it, but what remained was very firmly attached. Practically all the eggs were attached to this bark. No larvae were found on this limb, the bark not being loose enough to permit them to get beneath. Cracks in the wood were also examined as potential shelters for larvae, but none was located. It may well be that the normal shelter of the larvae is the dry bark of trees.

In the last week of August many of the hibernating masses of larvae were showing signs of activity. By the first week of September practically every larva was on the move. The masses broke up and moved away, if free to, or ran about the jars if imprisoned. September opened with delightful spring sunshine, the kind of warmth that feels greater than the thermometer indicates.

Maximum temperatures reached about 65° to 68° or 69°F., although some days felt considerably warmer than this. Having become active, it was noticed that the larvae remained active even when the weather coooled, as it did for a day or so.

A small percentage of the larvae did not hibernate, but moved about more or less actively until they died a few weeks after hatching. The large majority, however, hibernated as usual in dense masses, larvae from several batches of eggs mixing and amalgamating readily together. Many thousands of the larvae did not move a quarter of an inch after hatching four months previously. A few larvae actually survived a hibernation period of five to six months following their hatching (the maximum period, 27 weeks 5 days), but the majority lived about four to four and a half months. By the middle of October practically all of the larvae were dead, except, of course, the minute proportion that had been introduced into spider eggs and had started feeding.

The newly hatched larvae will travel for some considerable distance in a search for suitable cover under which to hibernate. This was proved experimentally by placing a batch of eggs in the centre of a large sheet of drawing paper and surrounding it at varying distances with varied objects—paper, cardboard, wood, and similar objects—suitable as potential cover. The larvae hatched on a warm day in May and soon dispersed in all directions. A day or two later every bit of material had a number of larvae sheltering beneath it. Three months later many were still concealed in the positions taken up.

The speed of the walking larvae varied a good deal; the fastest covered six inches in 55 seconds, but most took upwards of two minutes. The average rate may be expressed as about a foot in three to four minutes; that of the fastest, more than a yard in six minutes if walking were continued unbrokenly. Most young larvae would probably do this and, walking for considerable periods, cover relatively enormous distances.

With the cessation of hibernation and the scattering of the awakened larvae, they must seek out the egg-sacs of spiders in order to feed and continue their development. How this is achieved under natural conditions is not known, but it would seem that it is by the efforts of the minute larva alone. An attempt to discover whether the larvae are carried upon the body of the spider proved negative. A large number of larvae were imprisoned in a jar occupied by a large female *Lycosa*, and a similar test made with a large *Isopeda*. Both jars were of clear glass, and it was possible, with the aid of a hand lens to follow the movements of the larvae. These were observed over a period of several days, but in neither jar did any of the larvae reveal any disposition to attach thmselves to the spider. Several were seen to make contact with the legs of the spiders, but, with one exception, all turned away. One did for a while become attached to the hairs of the leg of the *Isopeda*, but this appeared to be more or less accidental. It soon disengaged itself. The weather at the time was fine and warm, and the larvae were constantly on the move.

A further experiment was made to see whether the spider's egg-sac possessed any special attraction for the Mantispid larvae, and whether they could penetrate the silken walls of the intact sac. A *Lycosa* egg-sac was placed in the middle of a sheet of cartridge paper. A few dozen larvae were liberated in a wide arc two or three inches distant from the sac. As far as could be observed, the sac appeared to have no definite attraction for them, but the experiment did prove the larval penetration of the sac wall. About a week later, when the sac was opened, it was found that it contained two live larvae, while a third was found to have penetrated the sac wall, crawled half-way through and then died. A further and more flimsily constructed sac of an unidentified spider was placed

twice as far distant from the liberated larvae. This was later found to contain one larva which had definitely started to feed.

As soon as the larva has penetrated the sac it commences to feed. In feeding the second and third instar larva drives its short, sharp, sucking mandibles into the egg (or spiderling) and apparently sucks until there is no more moisture to be obtained. An egg is a completely shrivelled, empty shell when discarded. Young larvae shift from one egg to another without at one time completely exhausting its contents. The insect maintains a secure hold while feeding. If a feeding larva is gently raised, the egg is not dropped, but is lifted on the mandibles.

It is probable that the young larvae begin feeding on the eggs but transfer their attentions naturally to the spiderlings as they hatch. One Mantispid larva was fed successfully on spiderlings—of an undetermined species—from the first. Towards the end of the feeding period the spiderlings were very active and capable of escaping from the observation cell when the glass was removed. The Mantispid larva was, however, able to impale them readily. It was noted that this larva was more active and less bloated in appearance than those fed entirely upon eggs.

A larva which had been feeding on eggs for five or six weeks fed readily and well upon the small spiderlings. Where spiderlings, incapable of walking but not quiescent, were added to the eggs under observation, the larva fed as readily on the spiderlings as on the eggs. It simply took, apparently, whichever was before it.

Larvae would feed upon *Latrodectus* eggs, but it was not found possible to breed them right through to maturity on these; they will, however, mature on the eggs of *Celaenia excavata*, *Ixeuticus robustus*, and can be transferred from *Latrodectus* or *Lycosa* eggs to those of *Celaenia* and still mature successfully.

Developing larvae, although fundamentally creamy-white in colour, become tinged with the colour of the eggs upon which they feed. *Latrodectus*-fed larvae are sickly white; *Celaenia*-fed are tinged with yellow; there is a touch of pale salmon-pink in *Lycosa*-fed larvae.

The greatest number of Mantispids known to mature in one egg-sac—that of a *Lycosa*—is seven. It was an exceptionally large sac. In it were found three or four surviving spiderlings together with an eighth Mantispid, an apparently half-developed larva that soon died. It seems certain that under the most favourable conditions—that is, within the largest sacs—not more than seven or eight could develop to maturity. Average sacs would nourish far fewer. In small sacs one Mantispid pupa alone was found, and no surviving eggs or spiderlings. In these, apparently, there is sufficient food to nourish one only. Up to four adults of *Mantispa vittata* have been bred from each egg-sac of an unidentified ground-dwelling spider collected by Mr. N. Rodd at Lane Cove, near Sydney, New South Wales.

Kishida (1929) records finding "three or five, sometimes eight," larvae of the Japanese *Eumantispa harmandi* Nav. in the egg-sacs of a Clubionid spider, *Chiracanthium rubicundulum*, and a Ctenizid which he names *Kishinouyeus typicus*. The latter is said to place its egg-sacs in the curled tips of grasses. Brauer states that only one larva flourishes in each egg-sac in *Mantispa styriaca* Poda.

On the basis of one egg-sac for four larvae (on an average), 500 egg-sacs would be required to feed a batch of 2,000 Mantispid larvae. The actual figure would be greater, since sacs large enough to feed three or four larvae appear to be rare.

A count of Lycosid holes found within a radius of two chains of a telephone pole bearing about a dozen Mantispid egg masses revealed that there were

about fifty. Something like 24,000 larvae would probably leave that pole and disperse over the surrounding ground, probably largely spread by the action of the wind. Many poles bear a vastly greater number of eggs than that in question. The percentage of larvae which succeed in establishing themselves in egg-sacs must be very small indeed and the mortality exceedingly high.

As several larvae may develop in one egg-sac—if large enough—the question arises: Do the larvae ever feed on one another? Actually one instance was noted, in the spring of 1947, of one larva killing another. Both were small and had not undergone the first moult; one was wrapped round the other when first noticed late one night. The pair was removed to another cell, where the struggle, unaffected by the transfer, was continued. Next morning there was only one survivor. The lifeless larva was limp and shrunken. Larvae as a general rule appear to ignore each other. Larval cannibalism would tend to occur in situations were insufficient eggs are available, as when too many penetrate one egg-sac.

A caudal sucker is present in the first instar larvae of *Mantispa vittata*, such as is mentioned by Hoffman (1936) in *Climacella brunnea* var. *occidentalis* Banks. This sucker is not readily apparent while the larvae are walking, unless forced suddenly to recoil. In walking, the legs are moved very energetically; there is no wriggling of the body, though the head is continually swung rhythmically from side to side. When, however, sudden recoil is necessary, the abdominal tip is quickly turned down, the sucker takes hold, and by a quick contraction of the body the larva is jerked back. Feeding larvae wrap their elongate bodies around the egg, so that their entire undersurface makes contact with the egg, the caudal sucker helping to maintain a grip on its smooth surface. When a larva moves from one egg to another a marked pull is exerted by the sucker, producing an unmistakable movement of the egg.

Shortly after commencing feeding on the spider eggs, the larva loses its campodeiform appearance and becomes swollen and maggot-like, with small thoracic legs. It is often difficult to determine exactly when feeding has actually commenced.

The larvae moult twice only during the period of feeding before spinning the cocoon. The first moult occurs about twenty-four days after the commencement of feeding. In the following instar the rate of growth is extremely rapid, and the second moult occurs some five days later. Moulting is apparently a critical period for the larva, for in captivity a number died while casting their skins.

The last instar (text-figs. 9, 9*a*) larva is eruciform, creamy-white, and with the minute thoracic legs almost, if not quite, functionless. It measures slightly under half an inch in length. Its general appearance closely resembles that of the larva of the Hive Bee (*Apis mellifera* L.). There is no evidence that the larva of *Mantispa vittata* moults immediately after hatching, as has been stated in the case of *M. styriaca.* Two moults occur during the feeding period in *M. vittata* as against the single moult reported in *M. styriaca.*

A day or two prior to the first moult the larvae appear to cease feeding. The first moult is probably more critical than the second, because with this the active campodeiform larvae transform into the much less active eruciform or maggot-like form. During the first instar the feeding larva grows considerably but, of course, retains the original chitinized head and legs. The latter, compared with the rapidly expanding body, appear very small, but serve well for walking until reduced to fleshy, peg-like rudiments by the first moult. With this moult the hard head capsule is lost also. In moulting the larva wriggles forwards from the skin, which splits anteriorly. The cast skin, particularly that of the

second moult, does not readily collapse, and retains more or less the form of the stout larva.

The brown coloured areas forming a pattern upon the upper surface of the body segments gradually disappear from the abdomen as the first instar larva grows. Those on the thoracic segments remain clearly visible as six small spots until they disappear with the first moult. In the second and third instars the skin is very transparent and fat bodies can be seen as white patches. The long dorsal vessel, functioning as a heart, can be readily seen pulsating.

Pupation and the Pupa.

About seven days after the second moult the larva commences to spin its cocoon within the egg-sac of the spider host. Three larvae under observation made normal cocoons, and each took about three days to complete spinning. The bloated larva assumes various positions while spinning, and steadily moves the posterior extremity of the body in arcs to form the cocoon. The silk issuing from the anus may be clearly seen during the early stages of spinning. The pointed posterior extremity of the body is apparently highly sensitive to touch. A fourth larva, which otherwise developed normally, for some inexplicable reason made no cocoon at all. It produced no silk, but simply pupated in the bottom of an observation cell. It proved to be a male; the other three were females.

Two larvae in particular were remarkably uniform in their development. Both were introduced to *Latrodectus* eggs on 7th October. Three weeks later they were transferred to *Celaenia* eggs. Both moulted for the first time on 31st October, which was twenty-four days after they had been first introduced to food. The second moult in each case occurred five days after the first. Both started to spin seven days later (12th November). One emerged from the cocoon on the 10th December, the other on the 11th.

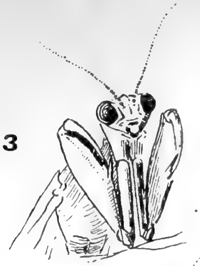
The cocoon, which is rounded or very slightly oval, is made of loosely woven silken threads of a somewhat greenish-yellow colour.

Pupation takes place within the last larval skin (text-fig. 10). There is no sudden and complete casting of this larval skin, but a pre-pupal period of eleven or twelve—or probably more—days ensues. Then the skin covering the forepart of the body is cast and the wing-pads, legs, and head and appendages of the pupa become apparent. The larval skin covering the abdomen is retained, to be shed only with the complete casting of the pupal skin on the emergence of the adult. This skin shows no signs of drying and hardening, but remains soft and flaccid throughout.

The pupa (text-fig. 11) after the moulting of the fore-portion of the larval skin is a translucent creamy colour. It remains motionless for about a week. Following this partial moult the creamy colour gives way to a translucent salmon and the prominent eyes appear black. The thorax of the pupa, after casting the larval skin, is short, gradually lengthening over the ensuing days; it does not, however, attain its full length until the final expansion of the adult after emergence.

After about eight or ten days the pupa (text-fig. 12) bites its way out of its own cocoon and then through the outer wall of the enclosing spider's egg-sac. Once outside it moves about actively for several hours before casting the pupal skin and emerging as an adult. The casting of the pupal skin appears difficult. The pupa anchors itself firmly to the abandoned egg-sac or some other convenient object by the feet; the skin splits down the median dorsal line of the prothorax; the head, prothorax and fore- and middle legs are withdrawn, and then, with considerable straining, the hind legs and abdomen are withdrawn. The insect then expands and dries itself.


2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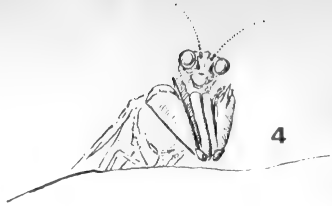
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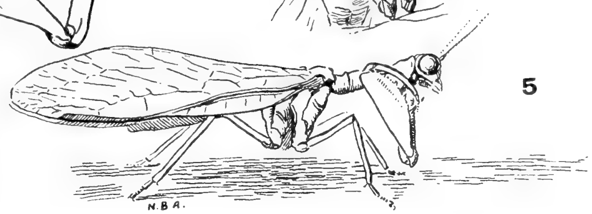
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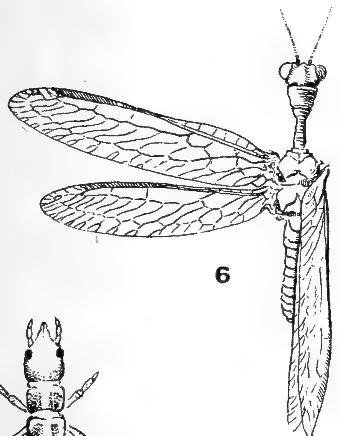
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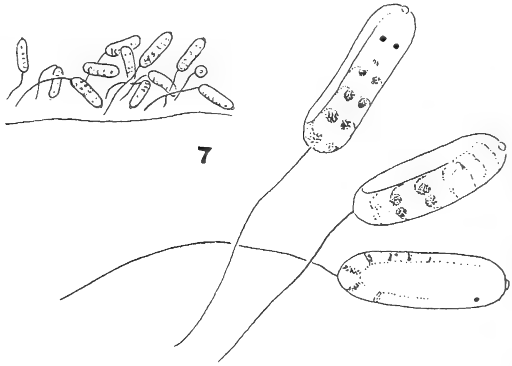
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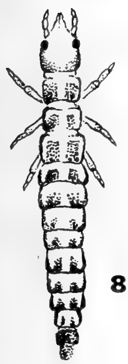
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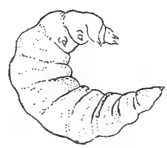
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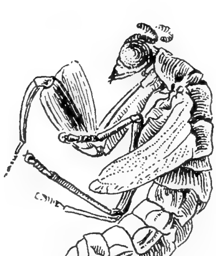
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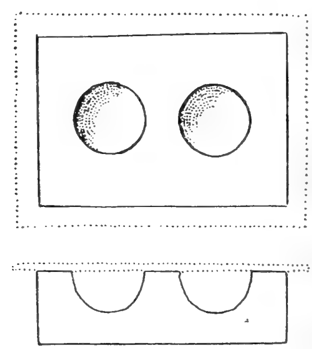
13

Details of the emergence of the Mantispid pupa from the cocoon are as follows: When a cocoon was examined at 6.50 a.m. on 11th December, 1946, movement could be detected within. The insect was obviously beginning to bite its way out. The mandibles soon appeared, and the biting and chewing was continued with occasional pauses until a hole large enough for its exit had been made. The insect finally crawled clear of its cocoon at 7.40 a.m., fifty minutes after its activity had first been noted. The actual emergence of this insect was not observed. The emergence takes about twelve to fifteen minutes. About half an hour later the insect is ready to fly.

Within the egg-sac the *Mantispa* leads a sheltered existence. It might be expected that its emergence from the sac is fraught with a certain element of danger. Whether any ever fall a prey to the spider, it is impossible to say. Only one instance of a Mantispid pupa emerging from the spider's egg-sac has been observed under natural conditions, and if all the pupae emerge similarly, there is slight chance of any being seized by the spider. It had long been considered that the pupae probably made their exit from the sac while it was being sunned by the spider; consequently the children at Willalo school had been asked to watch for such a possibility. Two boys actually saw this occur on 8th May, 1946. At the time they were watching a spider sunning her sac in the usual manner at the entrance to her hole. The day was bright and warm. As they watched, they saw a small hole grow in the top of the egg-sac and the head of a Mantispid pupa appear. The insect slowly crawled out of the sac and moved off from the hole over the ground. The spider, facing down its shaft, remained oblivious of all that was happening. The lads seized the insect too enthusiastically and killed it.

Spiders Victimized by Mantispa Vittata.

The Willalo Mantispids undoubtedly breed almost entirely in the egg-sacs of a large ground-dwelling spider, *Lycosa perinflata* Pulleine, which is very abundant in the district. This strikingly marked brown and white Lycosid was described by Dr. Pulleine from Whyte-Yarcowie, South Australia (Trans. Roy. Soc. South Aust., xlvi, 22 Dec., 1922, p. 84, pl. v, fig. 2). The spider is robust and measures 73 mm. in length.

Only one instance of the Mantispid breeding naturally in the egg-sac of any other species of spider has been observed; this exception was found in the sac of an unidentified *Isopeda*. When opened, the sac disclosed the cocoon of one *Mantispa*. *Isopeda* is rare in the district, possibly due to the scarcity of trees.

After the last week of February, 1946, every *Lycosa* sac obtainable was carefully examined. Some were removed from the spiders while being sunned at the burrow entrance; others were obtained by excavation. It soon became obvious that the search should have been undertaken earlier in the year. Few larvae were found. Most of the sacs contained pupae and several of these were bred out.

Occasionally a spider was found in possession of a sac in which every egg had been sucked dry, and from which the Mantispids had emerged. Three or four such sacs were found which had been rejected by the spiders. These were found near the entrances of Lycosid burrows.

On one occasion a *Lycosa* was found crossing the school yard with her egg-sac. She showed all the maternal care characteristic of these spiders, but

Figs. 2-13.—No. 2. Fore-limb of *Mantispa vittata*. 3-5. Various attitudes assumed while hunting prey. 6. Insect from above. 7. Eggs. 8. First instar larva. 9, 9*a*. Second instar larva, and head. 10. Pre-pupa. 11. Pupa after casting larval skin. 12. Pupa after emergence from egg-sac of spider. 13. Diagram (plan and section) of block used in rearing larvae. All figures enlarged except 13, which is reduced.

N. B. Adams del.

ultimate examination revealed that it was expended vainly upon three Mantispid larvae within the sac. Such unconscious exploitation of the spider's maternal instinct would possibly tend to enhance the chances of survival of Mantispid larvae and pupae within the egg-sac.

Variation in Size of Adult Mantispids.

Taken throughout, the size of adults of *Mantispa vittata* found at Willalo is fairly uniform. Occasionally, however, one finds a remarkably small individual. These dwarfed examples represent possibly two per cent. of the local Mantispid population. These are not, as might at first be concluded, necessarily males; actually most of them have been found to be females. These small insects are almost certainly the result of a shortage of food, a condition which would tend to occur when a number of larvae develop in one egg-sac.

Normal insects measure from 38 to 44 mm. across the outspread forewings; that of the dwarfed examples is usually from 23 to 27 mm. The larger insects measure from 19 to 22 mm. in length; the small about 13 to 14 mm. These measurements of body length are made from freshly killed material; there is considerable shrinkage of the abdomen in dry specimens. These dwarfed Mantispids appear relatively smaller when seen than the above measurements suggest, and they are slender in build. A fly that would be consumed by a large insect in a quarter of an hour would occupy a "dwarf" for two or three times that period.

Feeding Habits.

The Mantispids eat a variety of insects and can seize and overpower relatively large prey. The most formidable prey overpowered and devoured was a Hive Bee (*Apis mellifera*). The Mantispid was a large female and was definitely hungry. The bee made it a hard struggle, but failed to escape.

In captivity the insects eat blowflies (*Calliphora* and *Lucilia* spp.), house flies (*Musca domestica*), small moths and small Hymenopterous insects. A large blowfly provides an ideal meal for a hungry Mantispid, which may take half an hour or more to consume it. If not hungry, the insect may eat but little of the fly and release it to crawl round in an injured condition.

In nature the adult Mantispids lurk among leaves on the alert to capture insects. Numbers have been observed in the thick, fresh, regenerated foliage of sugar gums that had been "lopped" low.

Muscid flies (possibly *Musca vetustissima*) are very abundant in the district and probably provide the major part of the diet of the adult Mantispids. A Mantispid can see a fly from a distance of three or four inches. The action of seizing an insect is extraordinarily rapid. In captivity, even when enclosed in a large two-quart "Mason" jar, an insect when introduced is usually secured within a few seconds.

Although hundreds of ovipositing females have been watched, one instance only has been noted of prey being seized while an insect was laying. The insect in question seized and ate a small fly while uninterruptedly continuing her egg-laying. In one of the breeding cages a female Mantispid was observed to secure and eat a fly while in copula.

That cannibalism occurs under natural conditions seems practically certain, but it is uncommon. Even in captivity it is infrequent. Although many scores were kept under observation in the breeding cages—up to as many as forty in one cage—fewer than half a dozen instances were noted. Cannibalism apparently occurs where structural defects or weakness render an insect incapable of defending itself. One bred insect with defective forelimbs was soon seized by a sister insect and devoured.

Adult Mantispids have frequently been seen to grapple momentarily with each other, but most of such contests end harmlessly. No Mantispid will continue

the struggle for a meal indefinitely, and all observed have been disposed to "call the whole thing off" after a few futile "rounds". The prothorax and raptorial forelegs are amazingly mobile; from whatever position the insect is attacked it seems able to turn and grapple successfully with its attacker. In one instance an insect was simultaneously seized by two others. Held at each end of the body, it had no chance of defending itself and was soon eaten.

No instance of cannibalism was observed in nature, where, of course, it is much less likely to occur than under the artificial conditions imposed by the observation cage.

Where a number of insects, enclosed in a relatively small box, were sent by mail some cannibalism occurred.

Where hundreds of insects have been observed ovipositing in groups of various numbers, quite often large, not one instance of cannibalism has been seen among the insects so congregated.

The average life of the adult in captivity is about a month; a few have survived for six weeks.

Flying and Walking.

Insects of the Order Neuroptera are not, in general, characterized by strong flight. In comparison with other Neuroptera, Mantispids fly rather well. Their flight is steady and direct. They appear to fly only in warm sunshine, but do not take wing readily and are easily captured.

In walking the two hind pairs of legs alone are employed; the raptorial forelegs are held aloft, or forwards on the same plane as the body. The Mantispids are very sure-footed. Being small, they cannot straddle far enough to secure a grip of the leaf-edges on plants with leaves of medium or large size; consequently they are adapted to retain a footing upon smooth surfaces. They can readily walk up smooth glass surfaces and capture insects in any position. A Mantispid was observed to capture a blowfly as it was walking upside-down below the glass roof of an observation cage. Not only did it seize the fly, but ate it while in this apparently precarious position.

Mating.

Mating under natural conditions was not observed, but insects were seen in copula on several occasions in the observation cages. Preliminaries to mating were not observed, each pair being united when observed; any preliminaries must be very brief. Insects would be watched and no signs of pairing noticed; a few minutes later they would be found united. A reared male which emerged on 25th November, 1946, provided some indication of the possible course of mating preliminaries. Following emergence, this male displayed a strong disposition to mate. Unfortunately no female was available at the time and it was possible only to observe his approaches to another male. His mating instinct expressed itself by making direct approaches to the other and quickly seizing its forelimbs with its own. He then twisted round in an attempt to bring his abdominal tip in contact with that of the other. It was not until nearly a fortnight later that a female became available to place with him. By that time, however, his sexual impulse had completely failed, and no attempt to mate was made—as far, at least, as was observed.

This behaviour agrees very closely with that described by F. J. Killington for other Neuroptera (A Monograph of the British Neuroptera, i, 1936, pp. 162-165, Ray Soc. London).

When united the insects take up a linear pose, facing in opposite directions. They show little tendency to move about, but preen themselves—the forelimbs particularly—a great deal.

Pairing may occupy from half an hour to three hours, and after the separation of the insects the spermatophore is visible as a small globule of whitish, gum-like matter attached to the female genitalia. This soon hardens, and one female was observed in the act of biting it away from the extremity of her abdomen.

One female in copula was observed to seize a passing fly and eat it.

In one instance a female which was observed in copula on 20th March, 1946, oviposited exactly one week later. Her batch of eggs, which was smaller than usual, hatched in due time. Another female was imprisoned in an observation cage on the table at Willalo school. One day in November, 1946, a Mantispid flew through the window—a male. This was promptly caged with the female. Other duties occupied attention for a minute or two, and when again observed the insects were in copula. They remained united for nearly an hour. This female oviposited five days later. This was an unusual case, as the female deposited a further series of eggs a few days after the first. The entry of the male into the room where the female was imprisoned is interesting, and suggests the possibility that the female, when ready for pairing, may attract males from some distance.

Following pairing, the females displayed a keen appetite for food. It is possible that a very intensive feeding period follows mating. Two mated females under observation definitely did not devour their mates. Another, however, did turn cannibal and ate her mate, which had defective forelimbs (as previously noted).

Females greatly predominate numerically.

Mantispid and Mantid: A Brief Comparison.

(Text-figs. 2–5.)

The general similarity in form between the Neuropterous Mantispids and the Orthopterous Mantids presents a remarkable example of convergent evolution. It is neither necessary nor desirable to attempt here a detailed account of their morphological similarities and differences. One or two features of interest may be briefly noted.

The Mantispid's raptorial forelimbs, relatively more massive than those of the Mantid, are held in a more forward position than is the case with the Orthopterous insect. Mantispids always appear to be resting on their huge "elbows" because the coxae are never drawn up snugly against the elongated prothorax. A Mantid can retract its forelimbs so that they are, to all appearances, lost in fusion with the prothorax. With the legs in this position it can readily strike out at any suitable prey presenting itself. The coxae of the Mantispid are usually held forward when the insect is about to strike. Often the "elbows" are well in front of the head, with the femora doubled back against, or rather past, the coxae. The femora and coxae do not meet in "pocket-knife" fashion, as in the Mantids, but the femora actually pass the coxae on the outside and come to rest behind them. From this position they are flicked forward with incredible speed. Just before seizing its prey the Mantispid quickly throws back the antennae, which normally project forward.

The raptorial foreleg of the Mantispid is armed with fewer spines than is that of the Mantid. The tibiae of the former bear no spines, but are lined with fine stiff hairs which help the tibiae to hold the prey against the spikes of the femora. The femoral spines of the Mantispid, unlike those of the Mantid, are confined to a single row. The large basal spine, however, is situated well inwards so that the tibiae close between the row of outer spines and the large inner one.

There are certain important differences in the prothorax of members of the two groups. In the Mantid it is usually somewhat dorsally depressed and laterally flanged; that of the Mantispid is in the form of a rounded column and is slightly wrinkled transversely.

Compared with the Mantid, the Mantispid is much more particular regarding its toilet, and responds much more readily to the presence of foreign matter upon its body. A comparison of the toilet behaviour of the two insects may be made here.

As noted above, the Mantispid tibiae are equipped with fine, stiff hairs instead of spines. Now these hairs form an effective brush with which the insect cleans its eyes and head. On completing a meal the Mantispid deftly nibbles between each spine along the femur to remove any small fragments of its victim that may remain. The nibbling with the mandibles is carried along the inner tibia as well. Each forelimb is, of course, done separately, and in both Mantid and Mantispid this toilet activity is similar. Next, the Mantispid draws the tibiae across the head and eyes to brush those parts clean. Both limbs are generally used together, though they may be employed singly. After every brushing action or two the hairs of the tibia are quickly cleaned with the mouth parts. Having done this, the insect may not continue with its toilet any further, but it often completes the "clean-up" by proceeding with the following activities. The antennae are cleaned separately, each being drawn down and worked upon by the mouth parts. Next, the feet of the four walking legs are separately nibbled. Finally, the abdomen is brought forward between the legs and nibbled about the tip, but this is done rarely. It is rather a comical sight to see the insect engaged in this last toilet act, for, in order to bring the head and abdominal tip together, the long, mobile prothorax has also to be bent down and backwards considerably, so that the insect is almost rolled into a ball.

Actually the extent to which these toilet details are performed varies a great deal. Any of them may be done at a time, should it be necessary to clean some particular part. For example, the feet often pick up matter that is promptly removed by the mouth parts. Moreover, meals vary a lot as regards "messiness". With a large blowfly the Mantispid may almost bury its head in its thorax while eating. A small insect victim may necessitate little toilet activity. Some Mantispids seem more fastidious than others, and are nearly always engaged in some cleaning activity.

Since it was obvious that the spine-fringed tibiae of a Mantid could not be effectively employed for cleaning its eyes and head, an experiment was carried out that had been previously used with a Mantispid. The eyes were obscured with the lead of a red copying pencil that had been dipped in water; this produced an effective paint-like cover. The Mantispid so treated had readily cleaned its eyes with its very effective tibial brushes. Following similar treatment, the big green Mantid, *Tenodera*, remained unresponsive for some twenty minutes. Then it set about cleaning its eyes, and in doing this revealed an obscure anatomical feature which had not previously been noted in these insects. The Mantid began to rub its eye with its femur, using the inner part near its joint with the tibia. It rubbed the eye with its femur and then nibbled the limb, continuing these actions alternately until the eye was free from the obscuring paint. A superficial glance revealed nothing but a hard, smooth limb; a lens showed that the Mantid possessed an actual eye-brush—a small patch of fine, short, pale hairs. As a cleaning instrument it is inferior to that of the Mantispid. The Mantid, apparently, always uses its brushes singly. After about an hour it could see quite well.

Unsolved Questions.

While the investigations detailed above have provided a far more complete picture of the life history and behaviour of *Mantispa vittata* than any or all the recorded observations on other species in other parts of the world, there are many important details concerning it that remain unsolved. How far can the minute larva travel in search of spider egg-sacs unaided by the wind, which in

many instances must aid considerably in its dispersal? Is it purely by chance that the wandering larvae locate the egg-sacs? Observations suggest that this is the case, but it is possible that there may be obscure factors favouring the larva in its search. Do additional generations occur in a long season, as in the autumn of 1946, or does the wide range of time in the appearance of the adults simply reflect the varying periods taken by the larvae, hatched from the eggs of the previous season, in locating egg-sacs? Newly hatched larvae appear to be very reluctant to feed, but larvae that have hibernated commence feeding quite readily. Do the larvae develop a keen appetite for spider's eggs only after a long fast or at the conclusion of prolonged wandering? Two generations could not occur within the brief season of late spring, but this might be possible in autumn when conditions favour a prolonged season, as in 1946, when egg-laying extended from 13th March to 17th June. Eggs deposited about the middle of March would hatch no later than the middle of April, or possibly about a week earlier if laid in a sunny situation, and the larvae, if they soon found food and took no longer than the insects of the spring breeding experiments (about two months), could possibly emerge as mature insects in June. It is, however, possible that the Mantispids of late May and June are produced from eggs deposited in the late spring season, but this would depend upon whether any of the late spring larvae can survive as long as do the autumn-hatched larvae, which live as long as four and a half months. From experience with one batch of larvae of the early summer of 1945, it would appear that in the warm weather they could not survive long. These eggs hatched in extremely hot weather, in temperatures of 100°F. for days, and the larvae were exceedingly active. But, after little more than a week all were dead. Larvae must be able to survive for a considerable period in summer to account for the abundance of Mantispids in March and April, which must be produced from the eggs deposited in November and December. Survival probably depends upon the small larva getting into some deep, dark crevice or hole in the ground. The fact that attempts to rear autumn larvae in the autumn were unsuccessful, but that no difficulty was found in bringing them to maturity in the spring, after they had hibernated, suggests that there is no second brood within the autumn season. Such individuals that were induced to feed in the autumn developed poorly and slowly in comparison with those in spring.

Rearing Technique.

It was apparent early in the investigation that little could be learned of the development of larvae while enclosed in the egg-sac of the spider, and by opening the sac one risked injury to or destruction of the contents.

Cavity micro-slides were then tried as offering opportunities for microscopic examination of the larva during development. This method also failed, as the cavity was not deep enough to hold more than one layer of eggs; more would have been crushed by the glass coverslip. Larvae placed with eggs in the cavity did not attempt to feed.

Conditions in small glass tubes were a little more natural, and larvae enclosed in them, in a few instances, showed signs that they had begun to feed. It was, however, necessary to disturb the eggs periodically to bring to light the concealed larvae, all of which eventually died.

Ultimately a satisfactory means of observing the feeding and developing larvae was devised. This was accomplished by cutting deep, round, concave pits in blocks of "Caneite" and covering the whole with glass held in place by a rubber band to prevent the escape of the larvae (text-fig. 13). The concavities were slightly greater in volume than those of the larger *Lycosa* egg-sacs. This method was used successfully throughout, and permitted the addition of further eggs if considered necessary, as well as readily allowing examination of the developing larva from time to time.

Acknowledgements.

The authors desire to express their sincere thanks to Miss N. B. Adams for her drawings, and to Mr. P. Crosbie Morrison, Editor of *Wild Life*, for permission to reproduce a selection of his photographs. These add considerably to the value of their paper.

A Footnote.

(By K.C.McK.)

In conclusion, I desire to pay a tribute to the keen powers of observation and the patience of Mr. Hans Mincham, without which this paper would not have been possible. To him has fallen the "spade work"; the field work and the greater part of the detail of the life history of these strange spider-parasites are his. That this is a "joint paper" tends to obscure such facts. It is due to Hans Mincham's kindness in sending me living material from time to time that I was able to follow the life of the Mantispid, to confirm many of his observations, and in a few instances carry them a stage further than was possible for him, busy as he is with other and exacting duties.

I am sure that there can seldom have been a happier collaboration, during which notes were gathered, and a really voluminous correspondence exchanged. I for my part have found it very stimulating and worth while.

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EXPLANATION OF PLATES.

Plate xiv.

Figs. 1-4.—Attitudes assumed by *Mantispa vittata* when performing its toilet after a meal.

Fig. 5.—Egg mass on a branch.

Figs. 6-7.—Venation of fore- and hind-wing.

Photos.—1-4, P. Crosbie Morrison (from life); 5-7, from V. H. Mincham.

Plate xv.

Fig. 8.—*Mantispa vittata* making a meal of a house fly.

Figs. 9-10.—*Mantispa vittata* (8-9, from life; 10, dead).

Photos.—P. Crosbie Morrison.

NOTES ON BUTTERFLIES OF WESTERN QUEENSLAND.

By E. O. Edwards,
Menangle Park, New South Wales.

The following consists of an abbreviated record from notes taken by me as far back as 1928, while resident near Mitchell in Western Queensland, 372 miles west of Brisbane. At that time much of the country was almost in its virgin state, although clearing of the land was rapidly in progress. It should be noted that in most cases the absence or presence of butterflies in this area is essentially dependent on two factors: (1) weather conditions, (2) the type of food plant of the larva and its ability to resist dry conditions. Under normal conditions the spring months are dry and there is little general activity until stormy conditions start about Christmas time.

My main objective is to breed butterflies rather than catch them, but the fact that in some cases I found larvae of butterflies would not feed on some recorded food plants is not an indication that I am contradicting already authentic records, but rather that it indicates how some types have been compelled to transfer to introduced plants or other food plants as their natural plants become scarcer through civilization.

Family Papilionidae.

Papilio aegeus aegeus Donovan, 1805 (Orchard Butterfly).

At no time common. The only food plant of the larva recorded was the well-known Wilga (*Geijera parviflora*). Larvae would eat cultivated citrus as a second preference, but I have no record of their feeding on the wild lime, which was common in the vicinity and is the natural food plant of *P. anactus*. Average time from laying of the egg until emerging of butterfly during summer, 37 days. Imagos from eggs laid in March did not, however, emerge from the pupae until the following October.

Papilio sthenelus Macleay, 1827 (Chequered Swallowtail).

Common only during very good seasons. This butterfly set me a problem as the larvae will not feed on cultivated citrus or the native wild citrus. They die rather than eat it. In my garden I had the only citrus within 20 miles, and the butterflies showed no interest whatever in it. The butterflies' habit of skimming over the grass, which is quite different from other members of the genus, finally led me to concentrate on the billabongs and vicinity of creeks and rivers, where it is most frequently seen. Eventually, while riding along a billabong on the Womallila Creek I discovered a female laying on what appeared to be grass but was found to be a delicate herb which droops immediately it is picked, commonly known as Emu Grass or Native Lucerne (*Psoralea tenax*). Later I collected larvae on another and more hardy variety found on the Maranoa River (*Psoralea patens*). Naturally the habits of the larvae are different from other *Papilio*, due to the necessity of having to wander in search of food, as one larva would eat several entire plants before reaching maturity. This also accounts for a wide variation in the size of the butterfly, underfed larvae producing stunted specimens.

Although there is no odour from the leaves of their food plant, as is the case with citrus and wilga, the same pungent smell is emitted from the nuchal tentacle when the larva is disturbed. Larvae that pupated in captivity in March did not emerge until the following spring (September).

It would seem that the more rapid flight of this *Papilio* is directly connected with its life history, as much greater areas would require to be covered to assure continuation of the existence of the species.

PAPILIO ANACTUS Macleay, 1827 (Dingy Swallowtail).

Quite common. Natural food plant of larvae is wild citrus, but the cultivated types are readily eaten.

Family PIERIDAE.

DELIAS AGANIPPE Donovan, 1805 (Wood White).

Female caught on November 12, 1933. No other record.

DELIAS ARGENTHONA Fabricius, 1793 (Northern Jezabel).

Not common. Both the winter type (*seminigra*) and summer types were recorded. Eggs laid in May hatched in six days and the larvae pupated in August, commencing to emerge in September as the winter form. Larvae feed on various types of Mistletoe, including *Loranthus pendulus* and *Miquelii*. They readily change from one to another.

CATOPSILIA PYRANTHE PYTHIAS Waterhouse and Lyell, 1914 (Common Migrant).

Common during summer; entirely absent during winter and spring. The paler form with the pinkish antennae (*lacteola*) also prevalent. Larvae feed on a wild *Cassia* (*C. sophera* var. *shinifolia*). This plant will not stand frost and dies back each winter, shooting again in spring as conditions are favourable. Larvae and pupae on their food plant are also killed with the frost. All attempts to keep both larvae and pupae in captivity during winter failed. The larvae died and the pupae emerged no matter how cold it was. How, then, is the race kept going till next season? I am of the opinion that they continue breeding along the coastal areas of Queensland during winter, migrating inland to the western areas when weather conditions become suitable next summer. During the summer, the period from the laying of the egg to the emerging of the butterfly is about 28 days, but eggs laid in April emerge as butterflies in June. It is noteworthy that the larvae were confined to *C. shinifolia* and would not eat introduced plants of *C. fistula* or the western *C. australis*.

CATOPSILIA POMONA POMONA Fabricius, 1775 (Lemon Migrant).

Common during late summer, including both forms *crocale* and *catilla*. These different forms will mate with one another. Of three eggs known to be laid by a typical *crocale* only one of the resultant butterflies had the characteristics of *crocale*, and that was a male; the other two were a male and female of the ordinary type.

It took me three years to find the food plant of the larvae of this butterfly, which is *Cassia australis*, growing in widely separated patches. Larvae would not feed on other wild species of *Cassia* growing in the district, but a plant of *C. fistula* grown from seed, sent me by Dr. G. A. Waterhouse, was eaten by the larvae in captivity, although, strangely, the butterflies in their wild state did not show interest in the plant or lay eggs on it. Although *C. australis* is hardy and will resist the heavy winter frosts, the pupae would not remain over winter and, like the previous species, emerged during the winter, dying the first frosty night. Larvae were also killed by the cold. In summer the period from the laying of the egg to the emerging of the butterfly is about 21 days. First records of the butterflies after winter were in December, bearing out my opinion that they migrate from coastal areas.

APPIAS PAULINA EGA Boisduval, 1836 (Common Albatross).

Damaged female, collected 10th December, 1933. Only record.

ANAPHAEIS JAVA TEUTONIA Fabricius, 1775 (Caper White).

Very common. No variation to previous records.

TERIAS HECABE SULPHURATA Butler, 1875 (Common Grass Yellow).

The comonest of the genus in that district. Food plant of the larvae (*Sesbania aculeata*), a small plant with yellow pea flowers growing along the creeks and river banks. It fades immediately it is picked. The only way I was able to feed the larvae on it in captivity was to transplant the whole plant into a tin, roots and all, and keep it well watered. In that district the larvae would not feed on any of the native *Cassia*. In the butterflies the markings on the under wing and size of the marginal black bands on the upper wing were very variable.

TERIAS SMILAX Donovan, 1805 (Small Grass Yellow).

Never very common. The food plant of the larvae was the Buttercup Bush (*Cassia eremophilia*) and a small creeping prostrate perennial, growing along the river and creek banks, *Neptunia gracilis*, actually a Mimosa, hence closely related to wattle, but very different in growth except for the flower. Also feeds on *Cassia fistula*, butterflies laying eggs on the plant in my garden. Period from the laying of the egg to the emerging of the butterfly, 36–37 days.

Although I frequently mistook *Terias zoraide* for *T. smilax*, I have no authentic record of *zoraide*. It requires very careful examination to be able to distinguish the two. *T. zoraide* has no sex brand. Male *smilax* has a gray patch of scales on the under side of the forewing and salmon scales on the upper side of the hindwing. Brown markings were very variable on *smilax*.

TERIAS HERLA Macleay, 1827 (Macleay's Grass Yellow).

Rare. Unable to discover the life history, but suspect *Neptunia gracilis* (see *T. smilax*) as food plant of larvae.

ELODINA PADUSA Hewitson, 1853 (Narrow-Winged Pearl White).

Rare. Food plant of larvae is species of *Capperis*. These are so heavily attacked by *Anaphaeis java teutonia* that there is often not much left for other species to eat.

Ovum when first laid is white and elongated, rapidly becoming pink. It is laid on either the stem or leaf of the food plant. Period of hatching is six days, which is longer than normal in this district. Larva when first hatched pale green, finely haired with pinkish-brown markings on central segments and tail. When full grown, very variable. Pale green; head reddish-brown and finely haired; two reddish-brown small projections on 2nd segment, four on the 3rd and 5th, and one on each side of the 6th; four again on the 8th segment, forming a rectangular mark over the back; two more smaller projections on the 11th segment. Tail bifid. The segment projections become less conspicuous with growth. A faint yellow line down the back serves as camouflage, as the larva rests along the edge of a leaf where feeding. Pupa pale green, but very variable, especially the reddish-brown spots near the head. Period from laying of the egg to emerging of butterfly, 33 days.

Family DANAIDAE.

DANAIDA PLEXIPPUS Linnaeus, 1758 (Wanderer).

Occasional specimens seen. No record of breeding in the district.

DANAIDA CHRYSIPPUS PETILIA Stoll, 1790 (Lesser Wanderer).

Common in summer. Food plant of the larvae is a small climber, *Pentatropis atropurpurea*. Larvae frequently eat all the leaves and much of the stem. They also feed on another climber, *Marsdenia Leichhardtiana*. Life history period from laying of egg till emerging of butterfly, 25–27 days.

DANAIDA MELISSA HAMATA Macleay, 1827 (Blue Tiger).

Rare in good seasons; entirely absent in bad ones. Found only in very shaded areas along the river or creek banks. Unable to find any trace of the life history.

EUPLOEA CORINNA CORINNA Macleay, 1827 (Common Australian Crow).

Common in summer. Larvae feed on *Marsdenia Leichhardtiana*, commonly known as "Doubah". The metallic silvery, bell-like pupa of this butterfly is most attractive and might be described as "The fairies' looking-glass". Period from the laying of the egg till the butterfly emerges, 26 days.

Family NYMPHALIDAE.

ACRAEA ANDROMACHA Fabricius, 1775 (Glass-Wing).

Seen occasionally, but I failed to secure any breeding records.

HYPOLIMNAS BOLINA NERINA Fabricius, 1775 (Common Eggfly).

In February and March of 1928 this butterfly was especially common during a very good season. Otherwise rare and more often entirely absent. These picturesque butterflies prefer shady spots in which to rest, often congregating in large numbers and flying out suddenly when disturbed. The food plant of the larvae is *Alternanthera denticulata*, a small herb of the family Amarantaceae. Period from laying the egg until the butterfly emerges, about 51 days, which is noticeably longer than other butterflies in the district.

ERIBOEA PYRRHUS SEMPRONIUS Fabricius, 1793 (Tailed Emperor).

Rare. In spite of the fact that the food plants are Kurrajong and the Queensland Wattle (*Acacia podalyriaefolia*), both hardy plants, and that they breed throughout the year, they do not seem to increase. I am of the opinion that only a small number of larvae survive, many dying while changing the skin, due to the large spiny head being difficult to shed. They are slow breeders, remaining over winter as both larvae and pupae, frosts apparently having no effect on them. In one case a larva which hatched on the 11th of April did not pupate until the end of the following September.

PRECIS VILLIDA CALYBE Godart, 1819 (Meadow Argus).

Very common. Similar food plants as previously recorded for other districts, including the Everlastings and Plantains, with the addition of *Convolvulus valsinoidi*. Life history from laying of egg to emerging of butterfly, 45–47 days.

PRECIS ORITHYA ALBICINCTA Butler, 1875 (Blue Argus).

One record only, on 2nd March, 1928 (a very good season).

PYRAMEIS CARDUI KERSHAWI McCoy, 1868 (Australian Painted Lady).

Very common. Principal food plants of larvae are Everlastings. *Helichrysum apiculatum* seems to be most favoured. Period from laying of the egg to emerging of butterfly, 45 days.

PYRAMEIS ITEA Fabricius, 1775 (Australian Admiral).

Rare. Only occasional specimens are seen.

Family SATYRIDAE.

HYPOCYSTA METIRIUS Butler, 1875 (Common Brown Ringlet).

Common along the Maranoa River, where the food plant of the larvae, which is couch grass, grows. Colour of the larvae very variable from green to brown. Period from laying of the egg till butterfly emerges, 40 to 50 days.

Family LYCAENIDAE.

Subfamily LYCAENINAE.

CANDALIDES HEATHI HEATHI Cox, 1873 (Rayed Blue).

Common during summer, also present in spring. Food plant of larvae is a shrub known as Emu Bush or Berrigan (*Eremophila longifolia*). Ovum: grey; laid singly on leaves or stem of food plant; broad and flattened at top. Larvae do not eat shell after emerging. Larva: in early stages, pale green and hairy, flattened at the tail; green darkens with growth. Six red dorsal projections appear later, with a lateral pale yellow stripe, with faint lighter green markings on each segment. On the anterior segments a pair of yellow projections. Head grey. Attended by small black ants. Usually only one to each larva. When young the larvae eat the surface of the leaves, turning them black and giving a clue to their presence. With growth they eat all the leaf, starting from the tip. Pupae: typical of the species, found on the underside of the leaves of the food plant or sometimes under dead leaves at the foot of the food plant. Period from laying of the egg till the butterfly emerges very variable, varying from 46 to 130 days. Of four eggs laid by one butterfly on 23rd October, 1933, one emerged on 8th December, 1933, another on 2nd February, 1934, and the remaining two on 3rd February, 1934.

NACADUBA BIOCELLATA Felder, 1865 (Double-Spotted Lineblue).

Very common along the Maranoa River, when the wattles were in bloom. Larvae feed primarily on wattle blooms. The egg is laid on the bud against the stem and is hard to locate. It does not hatch until the flower is properly out, but when the flower fades the larvae will continue to eat the premature seed if not fully matured.

ZIZEERIA LABRADUS LABRADUS Godart, 1819 (Common Grass-Blue).

Very common. Nothing unusual in its life history records.

ZIZEERIA LYSIMON KARSANDRA Moore, 1865 (Dark Grass-Blue).

Common along the Maranoa River in summer and autumn, when the larvae feed on pea flowers. They will also eat the young pods.

PSEUDODIPSAS MYRMECOPHILA MYRMECOPHILA Waterhouse and Lyell, 1913. (Small Ant-Blue).

Found in large numbers around the foot of Bindee trees. Investigation revealed larvae in the cracks at the foot of the tree and under stones near by, where they were attended by large numbers of black ants; there was also a number of pupae under the stones. I do not think that the larvae fed on the leaves of the Bindee, as such a number of larvae could not have failed to leave traces. The only other trees anywhere in the vicinity were Euclaypts. However, the

Bindee was in flower and the ants were obviously trading backwards and forwards to the blossoms, but not carrying larvae in either direction. There was no activity whatever at night. My only conclusion is that the ants feed the larvae on pollen from the flowers. Larvae were only present while the Bindees were in bloom.

Neolucia serpentata Herrich-Schaeffer, 1869 (Chequered Blue).

Common at times on the Maranoa River or where the food plants of the larvae grow; these are varieties of saltbush (*Atripex*). They do not appear to be particular as to what variety.

Lampides boeticus damoetes Fabricius, 1775 (Pea Blue).

Common at times. Larvae feed on pods of legumes, including *Sesbania aculeata*, but the eggs are often laid on the stems, buds or flowers, leaving the larvae to find their own pods. They are attended by black ants. I found the larvae difficult to rear, due to cannibalism. They seem to prefer eating one another to pods.

Theclinesthes onycha onycha Hewitson, 1865 (Blue).

Not common. The larvae feed on a variety of wattle (*Acacia salicina* var. *varians*), found growing along the Maranoa River. Larvae are green with a faint yellow stripe down the back and small yellow horns on the front segments. They are attended by small black ants. The larvae did definitely feed on the leaves but there were no galls on the wattle. I mention this not in contradiction of previous records, but as proof that they will eat the leaves. Pupae are attached to the food plant; they are at first green, later turning brown; heavily marked with black.

Subfamily Ogyrinae.

Ogyris zosine zosine Hewitson, 1853 (Purple Azure).

Not common. Larvae and pupae were found under bark at the foot of a River Gum laden with Mistletoe (*L. pendulus*). The bark formed the entrance to a sugar ants' nest (*Camponotus nigriceps*). With the exception of small larvae they were in all stages. I am disposed to think that the very young larvae are either shepherded by the ants on the mistletoe or carried backwards and forwards into the inner chambers of the nest. I was not prepared at the time to sacrifice observations on this nest in an endeavour to prove the last opinion. Pupae were also under the bark and parasitized larvae. In an attempt to keep a closer watch on the habits of the ants and larvae, some were brought home with a few ants and placed in an improvised nest consisting of a log in a tin of sand with bunches of mistletoe protruding from a bottle of water let into the side of the trunk, the whole being in a tub of water to prevent the escape of the ants. The ants did not take kindly to the arrangements, but three of the larvae eventually pupated, all remaining in the larval stage throughout the winter. Two continued to feed, but the remaining one stayed dormant as a larva, pupating on 28th August, 1933 (they were collected at the end of April), and emerging as a butterfly on 10th October, 1933. The remaining two pupated on 19th December, 1933, one emerging on 3rd January, 1934, the other on 6th January, 1934. The two active larvae fed very little during the winter months and only at night. Meanwhile the nest was kept under observation on the river bank until on 4th August I found to my disappointment rather chaotic conditions prevailed. Bark had been torn from the trunk of the tree and was scattered around the foot. The ants' nest had been disturbed and the bark at the entrance

to the nest uprooted. Ants and larvae had gone. Evidence did not point to the Echidna, but to a flock of Black Cockatoos which had been operating for some time in the neighbourhood. There were only two days between the previous visit and the destruction, yet there was no trace of the ants. I consider that these ants were mainly dependent on the excretions from the larvae for their existence.

Ogyris oroetes Hewitson, 1862 (Silky Azure).

Not common. The two larvae which I secured and bred out were both yellowish-green and not brown, as in the case with other species. Though found under bark near the food plant (*Loranthus Miquelii*), they were more disposed to feed during the day, as their colour resembled the new shoots of the Mistletoe, but they did feed at night, as is the case with other *Ogyris* larvae. The pupae were typically *Ogyris*, but more reddish-brown than other types found.

Ogyris amaryllis meridionalis Bethune-Baker, 1905. (Interior Amaryllis Azure).

Common. The peculiarity of this species is that the eggs are laid in clusters of four or five on the new shoots of the food plant (*Loranthus Miquelii*). They are dull white, mandarine-shaped and heavily pitted. Young larvae almost colourless on hatching, and hairy. They become pale green and feed openly on the leaves, but they quickly turn a blue-grey and seek shelter under the bark or in cracks near the food plant, finally turning to a dark grey intricately and finely marked with red-brown and with a few gold spots on the anterior segments. They are usually attended by small black ants, but sometimes the ants are absent. They pupate under bark on the tree, the pupa being distinguished by its dark brown colour and pale arrow-shaped black markings along the back. The butterfly is often seen on the wing and seems to come nearer the ground than other *Ogyris*, which are disposed to confine their activities to the tree tops.

Ogyris olane Hewitson, 1862 (Olane Azure).

Common. Larvae found on *Loranthus Miquelii*, living under bark or debris near the food plant. A favourite haunt is in holes made by boring insects. They feed only at night. The larvae are reddish-brown with a faint dorsal black band starting from a triangular spot near the head and with short black arrow-shaped markings on each segment; slight projections along the back form into double rows of very small projections near the tail where the dorsal band broadens. Attended by small black ants. Pupae: darker reddish-brown than *O. oroetes* with markings darker, found some distance from the food plant, often near the butt of the tree.

When specimens of the butterflies were received by Dr. G. A. Waterhouse he immediately noticed a difference in shade of blue from the usual specimens of *olane* being collected. It had been thought that the type specimen in the British Museum had faded through chemical preservatives; however, a specimen from Mitchell sent to England was found to be identical with the original type-specimen (see Proceedings of Linnean Society of N.S.W., lix, 1934, p. 418). Hence this inland type becomes *O. olane olane*, while the kind previously known as *O. olane* by authors becomes *O. olane ocela* Waterhouse, 1934.

Subfamily Theclinae.

Ialmenus (species unnamed).

Specimens bred are considered by Dr. G. A. Waterhouse to be either a single new type or types, somewhat resembling the South Australian *I. icilius*. The

puzzle at present is that two markedly different life histories are apparently producing the same butterfly. A fuller account of what data I have will be given later in a separate paper.

Family HESPERIIDAE.

TRAPEZITES ELIENA ELIENA Hewitson, 1868 (Eliena Skipper).

Common in places where *Xerotes* grows, on which the larvae feed. The life history does not vary from that usually recorded (see Proceedings of the Linnean Society of N.S.W., lix, 1934, p. 413).

TRAPEZITES PETALIA Hewitson, 1868 (Common White-Spot Skipper).

Recorded only on 31st December, 1933.

TARACTROCERA PAPYRIA PAPYRIA Boisduval, 1832 (White Grassdart).

Collected specimen on 14th January, 1934.

TARACTROCERA ANISOMORPHA Lower, 1911 (Orange Grassdart).

Female caught 14th January, 1934.

OXYBADISTES WALKERI SOTHIS Waterhouse, 1933.

Specimens collected 31st December, 1933.

In conclusion, I am deeply indebted to the help and cooperation of Dr. G. A. Waterhouse, whose ever-willing advice was always greatly appreciated. It was Mr. C. T. White, Government Botanist of the Botanical Gardens, Brisbane, who so kindly classified the various food plants of the larvae, and to him I express my sincere thanks.

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REVIEW.

SILENT WINGS: A MEMORIAL TO THE PASSENGER PIGEON. Published by the Wisconsin Society for Ornithology, May, 1947. Editor: Walter E. Scott, Mendota Beach Heights, Madison 5, Wisconsin, U.S.A. Price: 1 dollar.

It is not our custom to review foreign books dealing with non-Australian matters, but, because of its message to all who love our fauna, the present subject merits an exception being made to the rule. This booklet is dedicated to the memory of the last Passenger Pigeon killed in Wisconsin, to which a monument has been erected, inscribed: "This species became extinct through the avarice and thoughtlessness of man." Audubon, observing the myriads of these flying birds which used to be a common sight, wrote in 1827: "The noise which they made, though distant, reminded me of a hard gale at sea, passing through the rigging of a close reefed vessel." Yet the species became extinct on 1st September, 1914, when the last surviving specimen died after 29 years in the aviary of the Cincinnati Zoological Gardens. This booklet deals in detail with what is known or remembered about the Passenger Pigeon and is beautifully produced and illustrated; some useful methods of protecting wild life are given, but to Australians "Silent Wings" is a solemn reminder to hold precious our heritage of native animals since, as it shows, even a superabundant species can become extinct through thoughtless destruction. To say that this booklet should never have been written is no reflection upon the authors, who have dealt lovingly and regretfully with their subject, but it is a reproach upon an earlier generation which deprived posterity of a beautiful and harmless creature.—ED.

BULLOCK'S MUSEUM.

By Tom Iredale.

(Plates xvi-xviii and text-fig. 1.)

Many boys and even girls have been known in the past to make collections of objects of various kinds, but mostly these are dispersed in favour of some other hobby or business at a comparatively early age. Few indeed have continued to keep their "museums" to their adult age, and fewer still have had or made the opportunity of continuing them all their lives, even in a humble way. Most of these few have concentrated their energies upon some small branch, as birds' eggs, butterflies, shells, coins, books, etc., and thus managed to see their small collections grow and keep them to the end. At the present time, owing to their easy manipulation and storage in small space, stamps have taken the fancy of most collectors. Man is a collector at heart and thus his desires are partly satisfied without a great deal of discomfort. To house a collection of natural history objects, even of the smallest size, as butterflies or birds' eggs, takes up a large amount of space and even money is necessary for cabinets in no small degree. Consequently there are very few large collections, and only one or two large enough to be called museums, now existing in private hands.

The British Museum was the earliest National Museum, and that was through the action of the private individual, Sir Hans Sloane, who brought together a museum. In his will he directed that it should be offered to the nation for a nominal sum on condition they continued it as a public museum, and, against all tradition, the offer was accepted and the British Museum came into being. That is not quite two hundred years ago, and there was current opposition in the Leverian Museum, for example. This collection, made by Sir Ashton Lever, ruined its owner and was offered in a lottery to pay his debts. At the time it was much more important than the juvenile British Museum, as Sir Ashton gained the most valuable objects from Sir Joseph Banks on his return from the famous Cook voyage which outlined the east coast of Australia. The lottery prize was won by a dentist named Patterson, who then forsook his calling to take up that of a showman, but after a few years forsook that also, and the contents of the museum were sold piecemeal by public auction. At the time of the height of the Leverian Museum a humble working jeweller in Sheffield was seized with ambition to form a museum, not with the idea of rivalling the Leverian, as he had probably never heard of it. We cannot state this as a fact, as the early story of this remarkable individual, William Bullock by name, is unknown, and although he rose to be "the wonder of his age", his end is also wrapt in mystery. Our first knowledge is gained in "A Companion to Mr. Bullock's Museum", issued in Sheffield, a small octavo book of 52 pages, describing some "Three hundred curiosities". This appeared in the year 1799, and it has been calculated from a statement later made that Bullock had started (in earnest) the collection in 1795. From this small beginning the museum increased so rapidly that Bullock claimed that in 1818, just before the dispersal of the contents, it contained 32,000 objects and that no less than £55,000 had been spent upon it. In recent years probably the only private museum for comparison would be the Natural History Museum got together by Lord Rothschild, part of which was sold and the remainder transferred to the nation.

These remarks refer chiefly to British museums, as most museums are now in public hands throughout the world, and none seems to challenge these instances. Apparently Bullock's little museum was a success, so that he transferred to Liverpool, probably a more important place at that time, and the success of his venture is told in the issues of the Companions—really all we

know about him and it. These Companions are very rare, and a complete series would be worth a lot of examination, as Bullock was not content to present a stereotyped review of the contents, but emended and increased the matter each time with additional novel information. Thus from the small 52-page effort the Companion increased in size until it reached over 200 pages and as many as thirty or more coloured plates. The first edition of the Liverpool venture was issued in 1801, but a second and a third edition were called for the same year; a fourth appeared in 1805, a fifth in 1807, a sixth in 1808. Then Bullock made another great step by transferring his museum to London, and his seventh edition was issued in Liverpool in 1809; but at a later date in the same year the seventh edition appeared in London, the place selected being Piccadilly. In this edition the museum is still referred to as the Liverpool Museum, but his Liverpool success was repeated and it soon became the London Museum, under which name it has been commonly known, although Bullock's Museum is the better known name today. Here again the Companions visualize the successful growth, as an eighth and a ninth edition appeared in 1810, a tenth in 1811, the eleventh missing (no copy unearthed), then enlarged twelfth and thirteenth editions in 1812, still a fourteenth and fifteenth in 1813, a sixteenth and seventeenth in 1814, and either Bullock got tired or the museum became less popular, as the seventeenth and last known edition was repeated in 1816. It must have been the former cause, as it is elsewhere stated to be still successful when Bullock decided to sell the contents by auction. Little is known of Bullock's reasons, and in the seventeenth edition advertisements appear of projected larger works dealing with the museum which do not appear to have eventuated. Perhaps Bullock thought he would like to travel, as he had made some trips to the north of Scotland and the Orkneys, securing specimens for the museum. Through these trips he became an outstanding figure in the history of British birds, as in the latter place he chased unsuccessfully a living Great Auk, one of the last of its tribe. Freed from the clutches of his museum, we know Bullock travelled to Mexico and elsewhere, but soon vanished from public ken, a report that he was alive in 1840 being the last word. Yet if ever a naturalist deserved a fine memorial, surely it was William Bullock, an abnormally strong personality, who was able to induce the cooperation of queens, princes, lords, nobility and the common man in the growth of his museum for the purpose of extending knowledge. It seems obvious that the bulk of his takings from visitors was expended on the acquirement of still further objects. Thus soon after he arrived in London he stated that the museum had been brought together "at an Expense of upwards of Twenty Thousand Pounds"; only three years later the figure was "Thirty Thousand Pounds"; and before its dispersal the amount, only five years more, had risen to "Fifty-five Thousand Pounds". These were huge figures one hundred and thirty years ago, and although there are priced catalogues of the auction sales in existence, there does not seem to be any total of the amount received on record. While the museum was world-famous during its existence, its death throes, like those of Samson, made its passing more memorable than its being. As above noted, it is not known exactly why Bullock resolved upon its destruction, the love of his life, but he resolved that it should be offered by auction and, regretting that he could not publish a catalogue giving all the details, acted himself as auctioneer. He excused himself for this, "a character he has not assumed from any unworthy pecuniary motive, but from a proper desire to apprize the bidder of the actual circumstances connected with the article he may wish to buy, that he may be fairly and fully in possession of its nature and character".

Two priced catalogues have been preserved, and many interesting notes have been published from these by Sharpe in the History of the Collections of the Natural History Department of the British Museum in 1906. A bibliographical account of the various editions, with notes from the British viewpoint, was issued by that great bibliophile, W. H. Mullens, in the *Museums Journal*, vol. xvii, 1917.

Neither of these articles is easily referable, so that the present opportunity to put on record the interest these Companions have for Australian students is taken. Messrs. Whitley, Musgrave and Iredale have been interested in this matter for many years and their enthusiasm was brought to a head by the recent acquisition by Dr. Marshall, who has loaned me the copy for comparison with three others of a beautiful copy of the fifteenth edition. One quotation alone will excite: "Birds. This department of the Museum has lately been enriched (through the liberality of the Royal College of Surgeons) by the entire collection made by Sir Joseph Banks and Captain Cook, during their voyage of discovery, among which are many unique and perfectly new subjects." Among the objects was "A large superb green Feather Cloak, the most valuable in the world, from the Sandwich Islands"; while it was claimed that "The Ornithological department of the Museum contains probably a greater number of species than is to be found in any other collection".

For Australian ornithologists the most important item is:

"Great Emu or New Holland Cassowary (*S. Nova Hollandia*). Upwards of 7 feet high.

"Lesser Emu, a distinct species, not half the size of the above."

The latter would be a specimen of the Kangaroo Island Emu, probably brought back by some of the companions of Flinders or even Flinders himself. [On the twentieth day's sale "Fourteen various specimens of Birds, from New Holland, collected by Capt. Flinders" were sold.] At the sale so little was thought of this extreme rarity that it was sold to the Linnean Society for £7 10s., the Greater Emu fetching £10 10s., and a Crane £6 6s., to the same buyers. Even after the Linnean Society had bought the specimen it was not greatly prized, as it has vanished, probably destroyed by moths. The Crane was our familiar Native Companion, listed in one edition as "A large species of crane from New Holland, where it was killed by Dr. Jamieson". In the eighth edition, issued in 1810, contemporary with Perry's "Arcana", the bird had been described but not named: "A large species of Crane from New Holland; seems nearly allied to *Ardea Antigone* of Linnaeus. Length five feet nine inches; breadth of the wing six feet three inches; general colour bluish-ash, except the quills and chin, which are black; top of the head without feather, ash colour; the regions of the eyes and back of the neck covered by a caranculated skin of bright vermilion colour. Presented by Dr. Munro, jun., who received it from New Holland."

"Water Fowl (Anseres) Case No. 1. Geese (*Anas*). Contains a number of the larger species. Among which are The Egyptian Goose (*Anas Aegyptiaca*) and the Canada Goose (*Anas Canadensis*). Both these birds lived some time in the Queen's Menagerie at Frogmore, and were graciously presented to the Museum by her Majesty, to whose condescension I am indebted for the birds in this case and many other fine subjects of natural history in this collection." Immediately afterwards came "The Black Swan of New Holland (*Anas atrata*), graciously presented by her Majesty".

Among the Pigeons may be cited "Several beautiful and rare birds of this family, collected during Cook's voyages"; and also the Parrots, "including similar rarities, undescribed" and sometimes types such as the "Horned Parrakeet, *P. cornutus*, brought by Sir Joseph Banks from the South Sea, the specimen described by Doctor Latham". Probably presented by Lady Banks, as other specimens are thus mentioned, and so on.

One of Bullock's greatest treasures was "A case of Birds of Paradise. This case contains, it is presumed, the finest collection of the birds of this kind in Europe, either in respect of number, variety or preservation." The case included some thirteen or fourteen kinds, including "The Gorget Bird of Paradise (*Paradisea Nigra*). This is a most splendid and beautiful bird, and likewise extremely rare. Presented by Lady Banks." This was the type and was bought by Col. Bruen for £19 8s., a bargain when it is noted that a specimen of the

Wenteltrap, a shell, fetched £22 11s. Another was the Black-bodied Bird of Paradise: "this beautiful and uncommon bird, which does not appear to have been seen by any English writer" was what it is now known as the Twelve-wired. Bullock's remark about the Red Bird of Paradise—"this specimen is believed to be the only one ever brought to England"—is correct, and apparently at that time there was only one on the Continent. The same applies to the Black Bird of Paradise (*Paradisea Furcata*), the Magnificent Rifle Bird today, which has been recorded as the only one in some authoritative works. The Lyre Bird appears sometimes as the New Holland Bird of Paradise and at others as the Botany Bay Bird of Paradise.

At the sale the case was offered as one lot and apparently Bullock would not accept the offer, as a couple of days later the birds were dispersed separately, and at the moment no details are available as to their ultimate fate.

So far birds, but the Museum had many animals also from New Holland, such as the Koala, which is illustrated in the seventeenth edition, which also contains a picture of the Duck-billed Platypus. The Porcupine Ant-Eater had

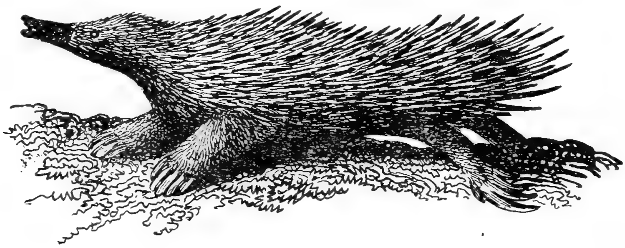

Fig. 1. A Porcupine Ant-Eater in Bullock's Museum.

been illustrated in the fifteenth edition, with a note from Shaw's Zoology, but also "Another Porcupine Ant-eater, varies from the above in the lightness of the colour of the spines, and their being shorter and more covered with stiff whitish hair; probably of a different sex, or a younger animal". There is also a note about the Wombat, apparently from Home's account, but no illustration. Kangaroos, Kangaroo Rats, Flying Squirrels and Pygmy Opossum are also mentioned.

On account of the great success of the London Museum, Bullock had a fine building constructed, and in the later editions the Companion is divided into two sections, the second being "A Companion to the Pantherion", which is thus described: "The Pantherion is an exhibition of Natural History, on a plan entirely novel, intended to display the whole of the known Quadrupeds, in a manner that will convey a more perfect idea of their haunts and mode of life than has hitherto been done, keeping them at the same time in their classic arrangement, and preserving them from the injury of dust and air; it occupies an extensive apartment, nearly forty feet high, erected for the purpose. The visitor is introduced through a basaltic cavern (of the same kind as the Giant's Causeway, or Fingall's Cave, in the Isle of Staffa) into an Indian Hut, situated in a Tropical Forest, in which are displayed most of the Quadrupeds described by naturalists, with correct models from nature or the best authorities, of the trees and other vegetables, productions of the torrid climes, remarkable for their richness or beauty of their fruit, or the singularity of their foliage; the whole assisted by an appropriate panoramic effect of distance, which makes the illusion produced so strong, that the surprised visitor finds himself suddenly transported from a crowded metropolis to the depth of an Indian forest, every part of which is occupied by its various savage inhabitants. The Linnean arrangement of Quadrupeds commences at the first opening on the left-hand of the entrance, where,

dispersed on rocks and the branches of a large Orange-tree, are about sixty species of the genus *Simia*; consisting of Apes, Baboons and Monkeys. It is difficult to determine the species of many of them, and others are not yet described by any Naturalist; those known are numbered, and will be found as follows . . . ."

A hundred years later most museums have decided to utilize "a plan entirely novel" for the exhibition of their collections, but they have omitted to give credit to the forgotten Bullock for the original idea. For this alone he should be always remembered. But the Museum included all the other groups of natural history, and among the Fishes was figured "Jacksonian Shark (*S. Jacksoniii*). This is a new species, lately discovered in the harbour of Port Jackson." The illustration is lettered "Port Jackson Shark", the name used today. The illustrations cover, as well as Birds and Quadrupeds, Turtles, Crocodiles, Chamaeleons, Snakes, Hercules Beetle, Bird-catching Spider, Crabs, Corals and Shells. These were all engraved by Howitt, one of the foremost British engravers, and mostly dated 1812, a few later.

As above mentioned, the text varies in nearly every edition, and in the eighth edition a dozen pages are allotted to shells; many New Zealand and Australian species are mentioned, probably also from the Cook voyages. This account is very noteworthy, as in 1810 the scientific names used are those introduced by Humphrey in the "Museum Calonnianum", as if they were in common use at the time. While modern museums are concerned with natural history objects, museums of old included antiquities and "curiosities", and among the latter in Bullock's were some Napoleonic relics. One such was the "Eagle carried before the Emperor on State occasions" and another "The original model of the Colossal Statue of Napoleon, twelve feet high, which was taken from the top of the celebrated Column of Peace in the Place Vendôme when the Allies entered Paris in 1814". Also "the Emperor's carriage, taken on the eve of Waterloo, and sent, with the officer who took it, by Marshal Blücher, to the Prince Regent, from whom it was purchased by its present proprietor for the sum of three thousand guineas".

The sale occupied twenty-six days, and it was attended by the directors of the principal museums in Europe, who contended for the numerous prizes in the collection, some fetching fancy prices, others just as low. Appreciation has mounted since, and many would like the opportunity to see them on sale now.

All the seventeen editions are very scarce and as they all differ in some details a comparison is always valuable. But very few examples seem to exist, and while Mullens recorded all the editions save the eleventh as having been seen by him he was only able to secure six copies for his own library. Whitley examined eight copies in the British Museum, but according to Ferguson some more have been acquired since Whitley was in England. Whitley also saw two copies in Oxford, and noted two in America, while there are about six in Australia. The last-named include one copy of the eighth edition in Whitley's possession, one of the thirteenth in Musgrave's library, one of the fifteenth in the Mitchell Library, another of the fifteenth in Dr. Marshall's library, and one of the seventeenth in Mr. Melbourne Ward's library, and, lastly, another of the seventeenth in the Mathews' Library at Canberra. This note may bring records of some others, which are most desirable, as the two copies of the fifteenth and of the seventeenth both differ in detail.

EXPLANATION OF PLATES.

Plate xvi.—William Bullock. (After Rowley.)

Plate xvii.—Upper figure: Bullock's Museum (later the Egyptian Hall), Piccadilly. Lower figure: Interior of Bullock's Museum. (After Bullock.)

Plate xviii.—Australian Animals in Bullock's Museum. (Top to bottom: Platypus, Koala, and Port Jackson Shark.) (After Bullock.)

NOTES ON REMARKABLE WASPS AND BEES.

WITH SPECIFIC DESCRIPTIONS.

By TARLTON RAYMENT, F.R.Z.S.

(Plates xix–xxi and text-figs. 1–2.)

INTRODUCTION.

Ten of the twelve bees and the wasp discussed in this paper were collected in New South Wales; two are indigenous to Western Australia and two were taken in Victoria.

The morphological structure of the several species is remarkable. The wasps are specially interesting, because they are rare and anomalous, and very little is known of the biology of this genus. I am indebted to Norman W. Rodd, of Lane Cove, New South Wales, for the specimens, and he has worked out the host relationships. He proposes to publish a paper at an early date.

The *Euryglossa* from Western Australia has been observed by Rica Erickson, Bolgart, to pollinate the orchid *Caladenia filamentosa* sub sp. *tentaculata*, and her notes are appended to the description of the allotype.

The huge scapes of the bees from Patonga Beach, Hawkesbury River, New South Wales, are surely unique in the *Apoidea*.

It is better to treat *Euryglossimorpha* Strand as a genus, for its characters are distinct and easily recognized, the "golf-club" of the male antennae is very conspicuous, and the strigil of the anterior leg of the female approaches the form of *Megachile*, and is far removed from the spined malus of *Euryglossa*. The details of the life history were supplied by Phillip Whiteley, of Orange, N.S.W., and is the first published account of the biology of these strange bees.

The black *Exoneura* was taken from a communal chamber with a number of eggs, by Owen Dawson, Cranbourne, Victoria. The species appears to follow the typical biological pattern for the genus. (See Rayment, July, 1946.)

The research was assisted by a small grant from the Trustees of the Commonwealth Scientific and Industrial Endowment Fund, and the author desires to express his appreciation of the courtesy received and the support accorded by the Chairman, Sir David Rivett, to his researches in the Australian Hymenoptera.

1. THE ANOMALOUS TRIGONALIDAE.

Excluding Schultz's monograph there is little information on these rare wasps in the literature of the *Hymenoptera*. Only two species have been described from Australia: *Mimelogonalos bouvieri* Sch. from Tasmania, and *Taeniogonalos maculatus* (Sm.) from Moreton Bay, Queensland, while *T. heterodoxus*, a new species from Lane Cove, New South Wales, is described below. Tillyard mentions an undescribed species from Stradbroke Is., Queensland, but the author has not been able to study this specimen.

The family is widely distributed, but nowhere plentiful, although specimens have been recorded from South, Central and North America, Africa, Burma, Europe and Australia. England has only one species.

Schultz (1907) monographed the family, with good diagrams in colour of the known species, and Bugnion (1890), too, published a study of certain genera. Imms (1942) lists a total of 17 genera with about 40 species. The South American genus *Nomadina* looks very like yellow-spotted parasitic bees.

The sole British species, *Trigonalys*, is said to be parasitic in the cells of *Polistes lanio* (Cambridge Natural History), and there is some evidence that these anomalous wasps are parasitic on the Aculeate *Hymenoptera*.

Imms (1942) quotes Clausen (1931), who says the eggs are laid on leaves and subsequently are swallowed by the larvae of saw-flies and various Lepidoptera. The larvae are spinose, and to complete their life cycle successfully must come into contact with Ichneumonid or Tachinid larvae. Trigonalids have been bred from the cells of Vespoidea, but this host relationship is said to be doubtful. In the face of this uncertainty in Europe Mr. Rodd's observations in Australia on the biology have a special interest and value.

These wasps are of particular interest in all comparative studies of the Order, because they appear to link the superfamilies *Ichneumonoidea* with the *Sphecoidea*, for they have the very long filiform antennae of many segments, the small compound eyes, and the divided trochanters of the Ichneumonids, although the general facies is that of a *Cerceris* wasp, with the sting issuing from the tip of the abdomen; the colours, too, black, red and yellow, are very similar to those of the *Philanthidae*, and the integument is coarsely rugoso-punctate. The quadrate head has the long vertex so characteristic of Crabronid wasps and the Megachiles, and bestows the "bull-head" aspect seen in combination with well-developed genae. The mandibles are elbowed and triangular and large, like those of leaf-cutting ants and bees, and there are several well-defined teeth, but the clypeus is excessively short, with a tendency to become porrect and emarginate, as in *Megachile*. The three small ocelli are close together, high on the vertex, the frons being occupied largely by two prominences which form the bases of the short-stalked ovoid scapes, similar stalks being seen in mutated forms of *Apis*.

There appear to be 25 segments in the slender flagellum, the five apical ones being the slenderest and terminating in a point. The labrum could not be examined, and there is a small malar space. The compound eyes are small, with the anterior margins parallel, but the genae are large.

The mouth parts are not fully exposed in the type specimen of the new species, and no satisfactory study could be made of these important organs, but it would appear that the labial palpi have four stout segments and the maxillary palpi six very slender ones. The apical segment of the labial palpus is spatulate and the whole organ is very hairy.

The thorax is larger than the abdomen, with the prothoracic collar produced laterally into "ears" which reach the tegulae and at the same time cover the tubercles. The parapsidal sutures are prominent, extending back to the scutellum as deep channels, as though indicating three separate plates. The scutellum is large, with a deep sulcus laterally, and the postscutellum has a median suture and a deep excavation laterally, as though to accommodate the base of the posterior wing. The metathoracic area is large and coarsely rugose, but flattened, not at all convex. The tegulae are small, but the tubercles are large. The pleurae have a finer sculpture and are well developed, with more hair.

The ovoid abdomen is small, with the first segment constricted off to form a short waist. The general aspect suggests a relationship to the *Mutillidae*, for there is a similar red colour and hairiness towards the apical segments, which are curved down and forward in a peculiar manner. The significance of this is evident when the gaster is studied, for sternite 2 is produced to a strong lamina (a spine in lateral view) directed apicad, and almost vis-a-vis a pointed structure on segment 6. Since segments 3, 4 and 5 are excessively constricted, a kind of arched structure is formed. Authorities give only five apparent segments for the abdomen.

There can be little doubt that the tubercles on sternite 2 of the bees *Parasphecodes arciferus* Ckll. and *P. fulviventris* Friese are the vestigial remnants of a structure of this type, and the ventral plates on the unique bee, *Meroglossa miranda* Raym., are homologous developments of the sternal structures. The apical structure suggests the elements of the apical plates of such bees as *Paracolletes* and *Anthophora.*

The legs are long and slender, with little hair; the short coxae are large, the anterior pair with a small process showing some relation to the spines of certain leaf-cutter bees. The short trochanters are not clearly divided; the femora having the best development; the tibiae are small. The hind calcariae lack strong teeth, being finely serrated, and carrying considerable hair, but they are remarkable since one is short and the other long, exactly as in the extraordinary bees *Goniocolletes.* The strigil of the anterior leg is short and thick, the malus having two teeth, and the velum narrowly concave, a form very suggestive of that of *Megachile* and *Exoneura.* The single calcar of the median pair is similar to the large hind one.

The basi-tarsi are long and slender, segments 2, 3 and 4 are short and cup-like in form, 5 being the broadest, with a very large pulvillus and bidentate claws. Each tarsal segment is produced to a small hyaline tooth apically.

The wings are large, with the pterostigma long and prominent, the anterior wings with a large dusky cloud along the costal margin; the posterior wings have twelve symmetrical but weak hamuli. The nervures are strongly developed. The pterostigma appears to be in a transitional stage, from a separate cell, for it is bounded by a distinct nervure.

There is a well-defined costal cell, and the large radial cell is not at all like the long sinuate radial of the saw-flies; the first cubital cell is large, but the three cubitals are very uneven in size; 1 is extremely long and wide, 2 very small and narrow, 3 is about the same length, but twice as high. The radial cell, where it meets the third cubital, is quite straight, as in the bees *Euryglossa* and *Meroglossa.*

The basal nervure is arched and fails to reach the nervulus, and the cubitus and the subdiscoideus nervures reach the margin of the wing.

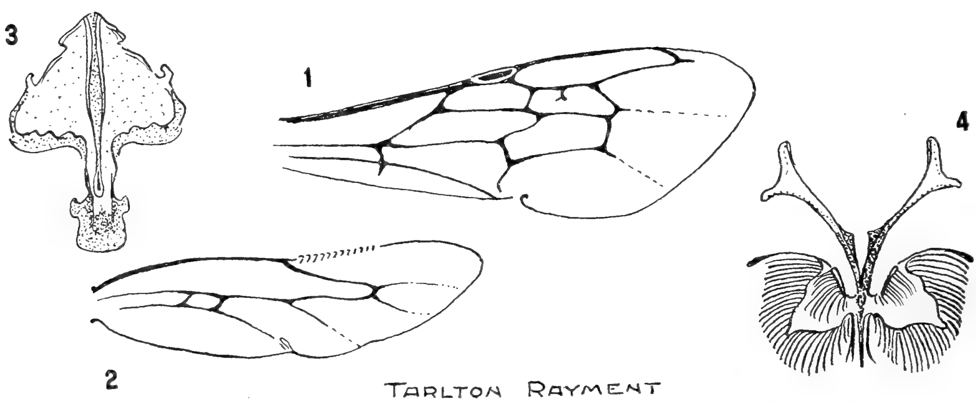

Fig. 1.—A male mutation of *Trichocolletes venustus* Smith. 1: Anterior wing, showing the short second intercubitus nervure. 2: Posterior wing, showing the small submediellan cell. 3 and 4: Seventh and eighth sternites of the male genitalia.

It would appear from the author's studies of the neuration of the Hymenopterous wing, that the second intercubitus often disappears, leaving only two cubital cells, the second and third being united, but referred to by taxonomists for convenience as the second cubital cell where only two are present, as in *Megachile.*

This opinion is based on a study of the wings of mutated forms in several genera, and splendid examples are provided by the wings of several male *Trichocolletes venustus* Sm. These bees were collected by the author on an excursion with the Field Naturalists' Club of Bendigo, Victoria, in September, 1947.

All the intercubiti in *Taeniogonalos heterodoxus*, sp. nov., have a line of weakness doubtless homologous with that in the remarkable Australian bee *Mellitidia manskii* Raym. and the European species *Andrena flessae* Pz.

TAENIOGONALOS HETERODOXUS, sp. nov. (Plate xix).

Type, female. Length, 12 mm. approx. Black, red and yellow.

Head quadrate, varicoloured. The whole insect coarsely and densely rugoso-punctate; facemarks yellow, shaped like large lunettes laterally, filling the space between the scapes and the compound eyes; frons black and shining; two yellow prominences around bases of scapes; clypeus excessively short, black, emarginate anteriorly, with a large yellow area laterally; supraclypeal area black; vertex broadly rounded, dull-red suffused irregularly with black; compound eyes small, claret-brown, anterior margins parallel; genae strongly developed, a large yellow mark; labrum not visible in the specimen before me; mandibulae yellow, subtriangular, black basally and apically, with some reddish suffusion, four prominent black teeth, strongly elbowed; antennae uniformly filiform, light ferruginous, 25 segments in the flagellum, and the almost ovate scapes on short stalks. The five apical segments of the flagellum are black and terminate in a point.

Prothorax black, suffused with reddish, with a leaf-like process laterally which reaches the tegulae and yellow tubercles; mesothorax black, with two bands laterally suffused with red, each with a yellow dot, the parapsidal furrows deeply incised, almost separating into plates; scutellum red, with a median black patch; postscutellum black, more or less suffused with red, and a yellow dot laterally, and a median sulcus; metathorax black, large, wrinkled, more or less suffused with reddish, but not convex; abdominal dorsal segments reddish, the margins more or less suffused with blackish, 1 with a yellow band, some yellowish hair apically; 2 with a lateral yellow band, others with yellow dots laterally; ventral segments blackish, shining, 2 developed to a lamellate spine, but the description requires an illustration to be intelligible.

Legs slender, ferruginous, the coxae black, the divided trochanters yellowish; tarsi ferruginous, slender, each segment with a hyaline nodule apically; claws strong, bifid, with a large pulvillus; hind calcar reddish, finely serrated, one long and one less than half the length; tegulae reddish; wings strongly suffused with blackish along the costal half; nervures strong, blackish-brown; cells: the wide costal cell is a prominent feature, and so is the small second cubital; pterostigma appears to be in a transitional stage from a cell; hamuli twelve, weakly developed.

Locality: Lane Cove, New South Wales; 22nd April, 1946; Norman W. Rodd.

Type in the collection of the author.

Allies: The new species has a superficial likeness to *T. lugubris* Westwood (1868), from the Amazon River, South America, and approaches it in the neuration and suffusion of the wings; the disposition of the yellow maculae and the structure of the sternal segments, but the American species is easily separated by the absence of the reddish colour.

T. maculatus (Smith,* 1851), 4½ lines, is easily distinguished by the yellow clypeus and apical segments of the abdomen, the absence of any red colour, and the 19 segments of the antennae. It was described from Moreton Bay, New South Wales (now Queensland).

EXPLANATION OF PLATE XIX.

1. Front of head-capsule of wasp, *Taeniogonalos heterodoxus* Rayment. Note the anomalous many-segmented flagellum.
2. Lateral view of abdomen to show sternal processes.
3. Posterior view of apical segments of abdomen.
4. Ventral view of sternal process.
5. Leaf-like development of prothoracic collar.
6. Each of the tarsi has a stout peg.
7. Fifth tarsus, with claws and large pulvillus.
8. There is one short and one long calcar in the hind pair.
9. The yellow trochanters are divided.
10. The strigil of the anterior leg approaches the form of *Megachile,* the leaf-cutting bee, and the mandibles have a similar likeness.
11. Anterior wing showing the suffused area and small second cubital cell.
12. Posterior wing; note the large costal cells.
13. The six segments of the maxillary palpus are slender and hairy.
14. The four spatulate segments of the labial palpus are stout and hairy.
15. The entire tegument of the wasp is coarsely rugoso-punctate.

2. NOTES ON THE BIOLOGY OF *EURYGLOSSIMORPHA NIGRA* (SMITH).

Euryglossa nigra Smith, New Sp., Hym. B.M., 1879, p. 13.

The ancient town of Orange, in France, was fortunate enough to have as a citizen the famous naturalist Jean Henri Fabre. Orange, in New South Wales, has a special interest for Australian naturalists, for it supplies the first account of the life history of a bee. Situated on the Western Slopes, it has a warm, sunny climate and a picturesque landscape dominated by an extinct volcano, Mount Canobolas, some 4,610 feet above sea level, and situated about eleven miles from the town itself. The soil of Canobolas is of the rich, dark-brown colour usually associated with decomposed volcanic ash, but the flora is a limited one. The only Euclaypt present is Mountain Silver Top (*E. sieberiana*), with scattered patches of Woolly Tea-tree (*Leptospermum lanigerum*). A few Capeweed flowers appear in spring, together with a rare Austral Blue-bell (*Wahlenbergia gracillis*?); there is very little grass.

A correspondent, Phillip Whiteley, visiting the mountain, observed a number of black bees of medium size darting among the grass-stalks, and ever and anon the smaller males gave some attention to the more industrious females. He captured several specimens of each sex and posted them to the author for critical examination.

The males are easily identified by the long, slender, amber-coloured antenna, with its contrasting black apex expanded until it resembles a miniature golf-club. The females, however, lack the peculiar "club" of the antenna, but the cleaner or strigil of the front leg is smooth, as in Plate xx, fig. 5. Both sexes have shining heads, and the equally glistening thorax is closely beset with large punctures, the abdomen having a peculiar silky sheen, dull in comparison with the other portions of the body.

* The Australian species, *T. maculatus,* was included by Smith in the genus *Trigonalys,* but Schultz (1907) proposed *Taeniogonalos,* and separated certain species, including *maculatus.*

For many years the author had concluded that these honey-gatherers were confined to high altitudes, but more recently he collected specimens near Sydney, in New South Wales, and at Croydon, in Victoria. A fellow-member of the Field Naturalists' Club of Victoria, J. E. Dixon, presented the author with several specimens which he had taken at Frankston, on the shores of Port Phillip Bay. None of these localities is flat, but the bees are more often found at higher elevations. Keith McKeown, of the Australian Museum, Sydney, sent another species, which he had obtained at Mount Victoria, in the Blue Mountains.

Whiteley gives the following account of his ascent of Canobolas. "We arrived on the top about 10 a.m. on the 19th of January, 1936, lit a fire and boiled a billy of water. After a drink of hot tea we searched about and found many hundreds of holes all over the top. There were heavy clouds about, and the wind was cool, although the sun was shining."

"Towards noon it grew warmer, and from then on, until we left at 2.30, the bees were very numerous. There were many scores of them; the females gathering cream pollen and amber honey from the Eucalypt, a twig of which I am forwarding to you for identification."

On the author pointing out to him that the nesting habits of *Euryglossimorpha* were unknown and the discovery of the nidus would be a genuine contribution to the science of entomology, Phillip Whiteley again climbed to the summit of Canobolas.

"On our next visit, on the 2nd February, we dug some of the nests out, but could not do so accurately owing to the stones in the ground. The holes go down at an angle and then turn back abruptly, so that the shaft is < shaped, with a cell at the bottom, which is only four inches down vertically from the surface."

"We got two or three cells out of what we thought was one nest, but found that one cannot tell which entrance-hole belongs to each, they are so close together. We did not see, on the second trip, any bees mating, though there were plenty on our previous visit."

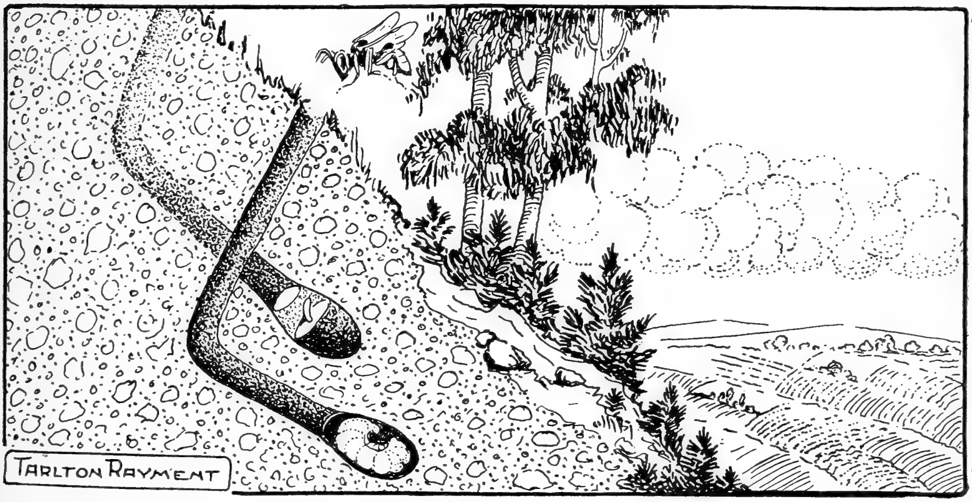

Fig. 2.—Graphic section of "nests" of *Euryglossimorpha nigra* (Smith) on Mount Canobolas, New South Wales.

Considering the size and strength of the bee, and the small amount of labour involved in the excavation of so short a shaft, it seems that the mother could easily construct without difficulty several chambers, and she probably does, since she is a-wing for five or so weeks. That there is more than one cell to each shaft is probable, but this point is not quite clear.

It is of interest to find the shafts so close together that it is difficult to distinguish between them. The shafts of *Euryglossa* (to which these bees are not closely related), though more or less grouped, are always well separated, for bees of the family Hylaeidae are regarded as of purely solitary habit.

In the material which reached the author's hands he found that 50 percent. of the bees were stylopized—the heaviest infestation yet recorded. Since the abdominal plates of the bee were deformed to permit the parasite to protrude between the body-rings, it is evident that the *Stylops* had in several instances emerged from such places, leaving the empty cavity to indicate the place of exit. The departed parasites may have been mature winged males, though the exact period at which such leave the host does not seem to be definitely known. Several authors assert that the male *Stylops* emerges from the larval bee, and only females remain in the adult host. The conformation of the body-plates proves that a mature *Stylops* had emerged, and it could not have been a female, since she is more or less attached to the interior of the host. She has no wings, of course.

Although only one species (a male, *Austrostylops gracilipes* Lea) of these remarkable parasites is known to the science, the author has the females of four other distinct species, one of which is in a Eumenid wasp which he captured at Sandringham, near shafts of *Halictus eboracensis* Ckll. However, in the absence of the respective males, systematic descriptive work is impossible, and the matter cannot be advanced beyond the existing unsatisfactory stage. The male *Stylops* is small and extremely rare.

The earthen cells of *Euryglossimorpha* are oval and measure 10 mm. at the long axis and 5 mm. at the short; the loose earth of the interior is bound in position by an open network of highly iridescent threads of some colloidal substance, and on these a comparatively thick, white skin lining has been laid down from the remarkably broad tongue. The skin cradle-gown does not adhere to the cell wall and may be removed intact. Mounted in glycerine and examined with a lens of high power, the colloidal skin shows no structure. It is much thicker and stronger than that of *Euryglossa*, and is similar to the tougher one of *Paracolletes*. Its size is, of course, that of the earthen chamber.

The stored cells are about half-full of a yellowish batter composed of the angular pollen-granules and amber-coloured honey from the gum-trees named; the later cells contained greenish honey and pollen from the "Woolly Tea-tree".

The white egg, slightly bowed, is deposited on the surface of the store of food, to which it is fastened at the caudal end by a clear secretion of the glands of the mother bee. The egg measured 1·60 mm. in length and was typical of all bees.

The feeding period could not be precisely ascertained from the material available, but larvae removed from the nest on the 2nd of February were all fully fed, the mesenteron being distended with the contained pollen mass. Since the mothers were collecting puddings during the first week in January, it would appear that about fourteen days are passed in consuming the store, the eggs taking from three to five days to hatch. The pupae lack the numerous nodes that are so prominent on *Halictus*, and more nearly resemble the babies of *Paracolletes*. The development of the larvae in the author's artificial cells extended over 210 days, so there is probably only one brood of males and females each season.

During the microscopical examination of the cells and the larvae, a number of white acarid mites, less than 1 mm. in length, were observed crawling about. These play an important part in maintaining a hygienic condition within the nest, since they live on any biological debris. This species is quite distinct from those studied in the nests of *Halictus emeraldensis* Raym., but there is no doubt whatever that the functions of both are alike.

A large, graceful, red Cryptine wasp was observed searching the apertures of the shafts, but it has already been shown that a close connexion exists between wild-bees and wasps of the genus *Labium*, for the activities of these parasitic wasps have been discussed at length in the author's monograph.

The nests are ravaged by a small, bristly, parasitic fly in the genus *Miltogramma*. It is marked on the abdomen with tan-coloured spots. The species was not determined, but a drawing is given at Plate xx, fig. 16.

Euryglossimorpha ruficauda, sp. nov.

Type, female. Length, 10 mm. approx. Black, with a faint greenish lustre on abdomen.

Head transverse, shining; face markedly convex; facial foveae conspicuous; frons with coarse large punctures and minute ones well separated; clypeus convex, polished, with well-separated large punctures; supraclypeal area similar, with a median suture that encircles the median ocellus; vertex broadly developed, with coarse and minute punctures; compound eyes with anterior margins parallel; genae with coarse and minute punctures, a few white hairs; labrum black, the glossa is exceedingly broad and deeply emarginate; mandibulae black, obscurely red apically; antennae black, obscurely brown beneath.

Prothorax with a few white hairs; tubercles black, with a heavy fringe of white hair; mesothorax polished, with well-separated coarse punctures and many minute ones; scutellum similar; postscutellum dull, with smaller punctures; metathorax shining, smooth, with an area delicately tessellate; abdominal dorsal segments with a faint greenish lustre, hind margins narrowly pale, 5 and 6 red, with ferruginous hair; ventral segments similar.

Legs black, with white hair rather sparse; tarsi piceous, with slightly yellowish hair, basitarsus very long; claws reddish-black; hind calcar reddish-black, with one large and several smaller teeth; tegulae black; wings dusky; nervures blackish and heavy; the second cubital very long, receiving the first recurrent nervure at its basal corner; pterostigma large and black; hamuli ten, strong.

Locality, Patonga, New South Wales; 16th January, 1947; Norman W. Rodd.

Type in the collection of the author.

Allies: *E. nigra* (Sm.), but easily separated by the red apical segments of the abdomen. It is better to treat *Euryglossimorpha* as a genus, for there are several excellent characters which separate it from *Euryglossa*. The strigil is very different, for the form is close to that of *Megachile*, the malus having no spines. (See Plate xx, fig. 5.)

These females were working on the flowers of a "smooth-barked" Eucalypt?

EXPLANATION OF PLATE XX.

1. Genitalia of *Euryglossimorpha nigra* (Sm.).

2. The titillatum of the genitalia is very remarkable and, under higher magnification, utterly unlike that of *E. antennata* Raym.

3. Labial palpi and the extraordinarily wide glossa of the female.

4. The labrum is subtriangular.

5 and 5*a*. Strigil of female and male. In this genus the malus of the former is without teeth.

6. The mandible has a subobsolete tooth.
7-8. Sculpture of mesothorax and abdomen.
9. The hind calcar of the female.
10. Maxilla and palpus; note the huge comb and other unusual characters responsible for the name of the genus.
11. The tergites are deformed to accommodate a *Stylops*, which is of a different species from that found on *Paracolletes providellus bacchalis* Ckll.
12. Sixth tergite with its naked red plate.
13. Hamuli or hooklets of the posterior wing.
14. Ovate fifth tarsus with tiny claws and empodium.
15. Neuration of the anterior wing.
16. A bristly parasitic fly belonging to the genus *Miltogramma* (SARCOPHAGIDAE).
17. The arista of the fly is conspicuously plumose.

KEY TO THE SPECIES.

The several species of *Euryglossimorpha* may be separated by the following key:

Whole insect shining	1
1. Apex of abdomen red	*E. ruficauda* Raym.
Legs black	2
2. Apex of abdomen black	*E. nigra* (Sm.)
Mesothorax densely punctured	3
3. Long white hair on face	*E. cincticornis* (Ckll.)
Whole insect dull	4
4. Sternites ferruginous, margins of tergites pallid	*E. abnormis* Raym.
Metathorax densely rugoso-punctate	5
5. Margins of tergites broadly paler	*E. proxima* Raym.
Very small insect, tarsi amber	6
6. Mesothorax rugoso-punctate	*E. antennata* Raym.
Flagellum greatly elongated, apical segment somewhat flattened	7
7. Clypeus densely punctured	*Euryglossa tenuicornis* Ckll.

The relationships of the unique bee *E. tenuicornis* are obscure, but it should be removed from *Euryglossa* and form the type of new genus, but it is better to defer naming this until the female is known. Professor Cockerell remarked that the filiform flagellum with its expanded apical segment approached the form of *Thaumatosoma*, which, however, is in the Megachilidae.

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3. A BEE AND AN ORCHID.

(Plate xxi.)

Bolgart, 80 miles north of Perth, is pushing its wheat-fields farther and farther over the gentle slopes, and the Salmon-gums (*Eucalyptus salmonophloia*) and the Wandoo (*E. redunca*) give way to the plough. Lower down are the odoriferous "Jam" (*Acacia acuminata*) and the York-gum (*Eucalyptus loxophleba*). Other plants are Sheokes (*Casuarina fraseriana* and *C. distyla*); the sedge-like Conostylis; a blue Goodenia (*G. caerulea*); delicate, scented pink Everlastings (*Helichrysum Lawrencella roseum*); the stiff Blue Stars (*Calectasia cyanea*), the white flowers of the Swamp Rainbow (*Drosera heterophylla*), and Rock-ferns. There are orchids, too—numbers of them: "Women's Caps" (*Thelymitra antennifera*), "Donkey Ears" (*Diuris longifolia*), and "Spiders" (*Caladenia hirta*, *C. deformis*, *C. filamentosa* and its subspecies *tentaculata*).

A correspondent in Western Australia, Rica Erickson, sends the following details of the visits of a tiny black bee to the orchid *Caladenia tentaculata*.

"The labellum is critically balanced on a 'claw', so that the size and weight of the insect is of prime importance. The bee alights and its weight pulls the labellum forward, leaving the flower open, but as the bee walks in and down it transfers its weight to a lower position, with the result that the labellum

is then pulled shut. It remains closed, so long as the weight of the insect is applied low on the inside of the base. As the insect struggles up, and backwards, to throw the labellum 'off balance', its thorax comes into contact with the pollinia, the viscid disc of which adheres to the mesothorax. Blowflies do go in, but are trapped to death, because their greater weight keeps the labellum so tightly closed as to prevent any escape."

The bees were determined by the author as *Euryglossa rejecta* Ckll., and one of the males had several pollinia glued to the mesothoracic disc. As these bees are not typical of the genus, some notes are appended, together with the specific description of the allotype female. The males were observed to rest in the white flowers of the Swamp Sundew, and many elliptical golden pollen grains were present on both males and females.

The males from Bolgart are not quite typical and differ from Perth (type locality) specimens by the colour of the ventral segments, the type having yellowish-ferruginous colour on the second and third.

Cockerell (1905, p. 476) said: "I put this aside as not belonging to the genus. I have concluded to leave it there for the present, however, to be separated when more is known about the group."

The large series received from Rica Erickson has permitted the dissection of several specimens, and it is clear that *rejecta* is not a typical *Euryglossa.* The head is large; the palpi of the mouth parts are jet black and articulated in a peculiar manner; the apical segment of the maxillary palpus has a spiral twist, with an indentation, the blade of the maxilla being equally black. The glossa is extremely wide, short and emarginate, but typical of the genus. A number of olfactory pore organs (group 3 of McIndoo) are clearly visible on the median plates of the wing bases.

The apex of the male abdomen has a truncated spoon-like process (seventh plate), but the smooth apical plate of the female is very similar to that of a female *Anthophora.* The abdominal fringes, too, are more like those of *Paracolletes,* to which the bees seem to have some affinity.

The white hind calcar lacks the strong teeth of the genus, for it is very finely serrated, the serrations being longer than is typical. The strigil of the anterior leg is typical of *Euryglossa,* and this microscopic organ is usually a stable index of affinities.

The author can do no better than Professor Cockerell, for he can find no morphological characters to warrant the separation of the species from *Euryglossa.* The finely serrated calcar is found in a few Halictine and Paracolletid species; in both genera the typical form is strongly dentate.

Euryglossa rejecta Ckll.

Euryglossa rejecta Cockerell, Ann. Mag. Nat. Hist., Ser. 7, vol. xvi, 1905, p. 476 (Perth, W.A.).

Allotype, female. Length, 7·5 mm. approx. Black.

Head transverse; face with long loose white plumose hair, a few black hairs laterally; frons rugoso-punctate; clypeus convex, shining, scattered large punctures, a delicate sculpture; supraclypeal area similar to clypeus, but rising to a fine carina that encircles the median ocellus; vertex rugoso-punctate, sharply developed, a few black hairs; compound eyes with anterior margins parallel; genae rugoso-punctate, a few yellowish hairs; labrum small and black; both the maxillary and labial palpi are conspicuously black; mandibulae long, acute, deeply grooved; antennae with scapes roughly sculptured, flagellum rather short.

Prothorax large for such a small bee, very rough; tubercles black, masked with a tuft of white hair; mesothorax shining, finely and closely punctured, with white and black hair; pleura sculptured like the clypeus; scutellum even more

shining, with finer punctures; postscutellum rougher and dull; metathorax with a large enclosed area of scale-like sculpture; abdominal dorsal segments bright, a delicate lineation, with fine punctures, hind margins amber, a few white hairs, a blackish tuft apically, and a small polished plate as in *Anthophora*; ventral segments with prominent fringes of smoky plumose hair.

Legs black, slender, with white hair, some black on median and hind tibiae; tarsi black, hair yellowish, very small; claws bifid, reddish; hind calcar white, with long fine serrations not typical of the genus; tegulae black and polished; wings subhyaline; extremely iridescent; nervures black and strong, radius pointed off the costa, and all markedly sinuate; the second cubital cell large and contracted above; pterostigma large, brown and black-bordered; hamuli five strongly developed.

Locality: Bolgart, Western Australia; September, 1947; Rica Erickson.

Allotype in the collection of the author.

Allies: Not very close to any described species.

Euryglossa ricae, sp. nov.

Type, female. Length 9 mm. approx. Black, yellow markings.

Head circular from the front; face shining; frons with a deep median depression that encloses the median ocellus; clypeus polished, convex, with scattered large punctures and a few white hairs; supraclypeal area similar; vertex sharply developed, with a tessellate sculpture, compound eyes with anterior margins converging only slightly below; genae with long lank hair; labrum blackish; mandibulae yellowish, black apically, with a median red band; antennae black, flagellum with each segment showing a ferruginous band.

Prothorax black; tubercles black, with a heavy fringe of white hair; mesothorax shining, with a scale-like sculpture and a few shallow punctures, a very few pale hairs; scutellum similar; postscutellum duller; metathorax with an area of shining scale-like sculpture; abdominal dorsal segments shining, with a finer scale-like sculpture and a few white hairs, 1 with the yellow basally cut into a curious black design like a fleur-de-lis, with a black mark laterally; 2 with the interrupted yellow band broadened laterally; 3, 4, 5 with a yellow isosceles triangle laterally; ventral segments yellow, each with a couple of black marks.

Legs black, knees of anterior and median pair yellow, anterior tibiae with a yellowish-red line; tarsi on anterior and median legs reddish-amber; claws reddish; hind calcar white, with four or five strong teeth; tegulae piceous; wings hyaline; nervures dilute brown, strong; cells: the second cubital contracted at apex, receives the two recurrents at equal distances; the first markedly sinuate; pterostigma dilute brown; hamuli seven.

Locality: Bolgart, Western Australia; September, 1947; Rica Erickson.

Type and allotype in the collection of the author.

Allies: *E. undulata* Ckll., which has red legs and black mandibles; *E. maculata* Sm. and *E. nitidifrons* Ckll., both of which have the apical segments of abdomen all yellow.

The species is dedicated to the collector in appreciation of her zealous assistance.

Taken on flowers of *Baeckea camphorosmae.*

Euryglossa baeckeae, sp. nov.

Type, male. Length, 5 mm. approx. Green.

Head transverse, greenish-purple lustre; face with a few white hairs; frons rugose; clypeus tessellate, green, a few punctures; supraclypeal area rising to a fine carina that reaches the median ocellus; vertex adapted to the mesothorax,

finely rugose; compound eyes with anterior orbital margins parallel; genae with long white hair; labrum blackish; mandibulae blackish, with an obscured red patch apically; antennae with black scape, but flagellum yellowish-ferruginous beneath; numerous large pore-organs on black parts of flagellum like pale oval scales.

Prothorax with a metallic green lustre; tubercles black, with a fringe of white hair; mesothorax strongly convex, purplish green, a strong tesselation which seems to run in concentric lines; scutellum blackish, with finer sculpture; postscutellum duller, metathorax large, an extensive enclosed area with an excessively coarse scale-like sculpture, a greenish lustre, abdominal dorsal segments clavate, dull, a microscopic lineation, an obscure greenish lustre, 1, 2 and 3 with a pale luteous band apically and basally (some specimens with only a spot on 1); ventral segments yellowish-ferruginous.

Legs with coxae and femora black, knees and tibiae ferruginous, median and hind tibiae infuscated; tarsi yellowish, hind one suffused with blackish; claws yellowish; hind calcar finely serrated, white; tegulae pale amber, somewhat suffused with blackish; wings hyaline; nervures brown, strong; second cubital cell almost as large as the first; pterostigma dark-brown; hamuli about five.

Locality: Fairleigh, Bolgart, Western Australia; September, 1947; Rica Erickson.

Type in the collection of the author.

Allies: Plainly between *E. walkeriana* Ckll., which has ferruginous mandibles and black abdomen, and *E. inconspicua lutea* Raym., which has a polished clypeus, and ferruginous mandibulae, and luteous bands on abdomen.

On flowers of *Baeckea camphorosmae.*

At first I thought the largest of these might be the males of *E. ricae*, but the sculpture of the abdomen is very different.

4. DESCRIPTIONS OF BEES.

Palaeorhiza hieroglipbica Raym.

Palaeorhiza hieroglipbica Rayment, A Cluster of Bees, 1935, p. 666 (Mt. Tambourine, Q.).

Allotype, female. Length, 8 mm. approx. Black and yellow.

Head oily-bright, long and narrow, face-marks yellow, resembling those of *Euprosopis elegans*, the wide lateral ones ending in a peculiar division with a large median lobe; frons narrow, elevated, with a median suture that encircles the median ocellus; coarsely punctured; clypeus aciculate, with a wide yellow band, amber anteriorly; supraclypeal area yellow, rising to a high dome; vertex rugoso-punctate, black, in sharp contrast to the yellow of the postoccipital region; compound eyes converging below in a marked manner; genae black, with the occipital yellow continued down as a wide band; labrum and mandibulae black; antennae black above, ferruginous beneath.

Prothorax with a wide yellow collar, a large yellow patch adjacent to the tubercles, tubercles butter-yellow, large with fringe of white hair; mesothorax black, a wide yellow band above the tegulae like an epaulette; shining, with even puncturing on a fine tessellate sculpture; scutellum black, sculptured similarly, with a large yellow triangular mark laterally; postscutellum with a finer sculpture; metathorax large, black, oily-bright, a delicate tessellate sculpture; some white plumose hair laterally; abdominal dorsal segments black, with a silky lustre, a few punctures, and short erect white hairs, hind margins depressed; ventral segments similar.

Legs black, more or less suffused with amber; claws reddish; hind calcar pale amber; tegulae piceus; wings dusky; nervures dark sepia; cells: the large

quadrate second cubital receiving both recurrents, the second recurrent at its apical third; pterostigma large and blackish; hamuli few and weak.

Locality: Narooma, New South Wales; 30th August, 1947; Norman W. Rodd.

Type in the collection of the author.

The collector thought it was a black species of *Euprosopis*. Although the localities are far apart (the male was described from Mt. Tambourine, Q.) I believe the sexes as associated by the collector are correct. This record adds the species to the fauna of the State.

The females were visiting *Prostanthera* sp. and also the "Wild Raspberry", *Rubus* sp.; the males were taken on the latter plant, and females were taken on the 14th December, 1946.

Sphaerhylaeus bicoloratus, sp. nov.

Type, male. Length, 6 mm. approx. Black and yellow.

Head almost circular from the front; face entirely lemon-yellow, the lateral marks reaching almost to the vertex as long finger-like extensions; frons completely masked by the huge bicoloured spherical scapes; clypeus evenly punctured, but not closely, a few white hairs; supraclypeal area yellow, with a high-domed pattern; vertex black, rugoso-punctate; there are two deep black depressions to accommodate the extraordinary scapes; compound eyes with anterior orbital margins almost parallel; genae lineolate with some puncturing and white hair; labrum yellow (the labial and maxillary palpi of these bees are black); mandibulae black, with a subapical reddish mark and a yellow dot; flagellum black above, ferruginous beneath, the enormously dilated scapes ruggedly punctured, and divided obliquely, one half being black, the other half yellow, the black forming a V from the front.

Prothorax with an interrupted yellow line; tubercles yellow; mesothorax shining, evenly punctured with far more numerous microscopic punctures which could be overlooked; scutellum similar, punctures not so close; postscutellum rugoso-punctate; metathorax covered with dense coarse anastomosing rugae, perhaps vermiform; abdominal dorsal segments black, bright, closely punctured on a minute rugose sculpture, laterally there are a few white hairs on the margins; ventral segments black, shining, with scattered coarse punctures.

Legs black, femora and tibiae somewhat dilated, a little obscure red and a touch of yellow on the anterior tibiae; tarsi black; claws and pulvillus blackish-red; hind calcar blackish, finely serrated; tegulae piceous; wings dusky; nervures blackish-brown, the two recurrents at equal distances inside the intercubiti; the second cubital contracted at its apex; pterostigma blackish-brown; hamuli six or so very weak.

Locality: Narrow Neck, Blue Mountains, New South Wales; 15th December, 1944; Norman W. Rodd.

Type in the collection of the author.

Allies: These very remarkable bees are not close to any others and are easily recognized by the excessively large bicoloured scapes. These records add the genus to the fauna of the State. The genotype, *S. globuliferus* Ckll., was described from Western Australia.

These males were visiting the large red flower-heads of the "Waratah", *Telopea*.

Sphaerhylaeus gibbonsi (Ckll.).

Hylaeus gibbonsi Cockerell, Records of the Australian Museum, vol. xviii, 1929, p. 223 (Sydney, N.S.W.).

Allotype, male. Length, 8 mm. approx. Black and yellow.

Head subcordate from the front; face-marks butter-yellow, wide lateral ones reaching to the scapes, and the orbital margins level with the clypeus; frons hidden by the enormous globose scapes; clypeus yellow, aciculate, a black mark laterally, a narrow carina that reaches to the apex of the long yellow supraclypeal area; vertex with contiguous punctures of even size; compound eyes markedly converging below, and the anterior margins with a line of deep pits, from each of which emerges a stiff peg-hair; genae rugoso-punctate, with a few pale hairs; labrum black, small; mandibulae black, acute, deeply furrowed; flagellum black above, ferruginous beneath, segments 1 and 2 and the scapes black, the latter excessively dilated, with a pear-shaped yellow mark laterally, a few long pale hairs.

Prothorax large, butter-yellow; tubercles large, butter-yellow, with a fringe of white hair; mesothorax entirely black, oily-bright, closely and evenly punctured on a minutely tessellate sculpture; pleura with large punctures; scutellum similar and slightly bi-gibbous; postscutellum with close punctures; metathorax with an area like a Moorish arch, the very fine rugae merging into the coarse tessellate sculpture, some few black and white hairs laterally; abdominal dorsal segments black, dull sheen, microscopically lineate, with scattered punctures of medium size; ventral segments more coarsely punctured, the apical segments invaginated in a peculiar manner that is difficult to describe in words.

Legs black, with all the femora dilated, and tibiae slightly so, some white hair, the anterior legs are obscurely red anteriorly; tarsi black; claws and pulvillus black; hind calcar black, finely serrated; tegulae black, dull, finely punctured; wings dusky; nervures blackish-brown, strong; cells: the long second cubital receiving both recurrent nervures; pterostigma blackish; hamuli about seven very weak.

Locality: Male, Cowan, New South Wales; 7th April, 1947; Norman W. Rodd.

Allotype in the collection of the author.

Allies: A most remarkable bee, not close to any others. Differs from the genotype, *S. globuliferus* Ckll. by the structure of the abdomen; from *S. procurvus* Raym. by the head and eyes; from *S. bicoloratus* Raym. by the scapes. We must regard *Sphaerhylaeus* as a genus, although published as a subgenus of *Gnathoprosopis* by Cockerell.

The males were visiting *Pultenaea* sp., but females also were taken within a short distance, at Cowan, New South Wales, on 30th August, 1947.

The sexes as associated by the collector are no doubt correct, and the female conforms perfectly to Professor T. D. A. Cockerell's adequate description, except that the tegulae on the Cowan females are jet black—dark-brown on the type.

The females show a little difference in structure from the typical Hylaeid form; for the face is very long, with the peculiar sculpture of *Meroglossa*, and the broad mandibles are sub-dentate, so that they are almost spoonlike; the hind calcar is finely serrated, and the strigil of the anterior leg is not typical of *Hylaeus*, but approaches that of *Gnathoprosopis*, as do the mandibles. It is regretted that no specimens were available for dissection and microscopical study of the anatomy.

Paracolletes viridicinctus Ckll.

Paracolletes viridicinctus Cockerell, Ann. Mag. Nat. Hist., (7), xvi, 1905, p. 482 (Tasmania).

Allotype, male. Length, 7 mm. approx. Black, slightly metallic abdomen.

Head transverse, shining; face with long loose hair; frons rugoso-punctate; clypeus convex, shining, long loose pale hair, a few black ones laterally, numerous shallow punctures on a wrinkled sculpture; supraclypeal area shining, a few

punctures, rising to a fine carina that encircles the median ocellus; vertex with black hair; compound eyes converging below; genae wrinkled, with long loose white hair; labrum black; mandibulae black, reddish apically; antennae black, flagellum obscurely brownish beneath.

Prothorax black; pleura with much long white hair; tubercles black, mesothorax shining, with sparse punctures on a scale-like sculpture, a few black hairs; scutellum similar, with a median depressed line; postscutellum rougher; metathorax with an enclosed area of coarse scale-like sculpture; a large amount of white hair laterally; abdominal dorsal segments shining, with the slight metallic sheen somewhat brassy, hind margins depressed, a microscopic tessellation; ventral segments polished.

Legs black, with white hair; tarsi obscurely reddish-black; claws reddish; hind calcar pale; tegulae blackish, polished; wings subhyaline; nervures brownish, strong; second cubital contracted at apex, receiving first recurrent at about its middle; pterostigma blackish; hamuli about seven.

Locality: Black Rock, Victoria; 26th September, 1947; T. Rayment.

Allotype in the collection of the author.

Allies: *P. providus* Sm. The females have the brassy lustre over the whole abdomen—only on margins in type from Tasmania—and a scale-like sculpture. Females laden with yellowish pollen from *Casuarina distyla.* The introduced honey-bee has learned to gather the entire gravid anthers of this plant (Rayment in MS.).

Halictus patongensis, sp. nov.

Type, male. Length, 8 mm. approx. Black and red.

Head transverse, black, with loose white plumose hair, shining; frons densely and coarsely punctured; clypeus shining, anterior half amber colour, with a pointed median extension; supraclypeal area closely punctured; vertex closely rugoso-punctate, with the three rather large ocelli prominently elevated; compound eyes converging below; anterior margins sinuate, almost emarginate; genae with long white hair; labrum and mandibulae amber; antennae very long, black above, ferruginous beneath, the segments of the flagellum obliquely crenulate, scapes black.

Prothorax with a narrow band of white mossy hair; tubercles amber, suffused with black, a heavy fringe of white hair; mesothorax shining, finely rugoso-punctate, a few pale stiff hairs on the disc, a little mossy white hair near the scutella suture; scutellum bigibbous, elevations shining, almost impunctate, otherwise it is distinctly and closely punctured; postscutellum rugose, with long white loose hairs; metathorax very long, shining bright, with a few large coarse rugae on the coarse tessellate integument, some long loose white hair laterally; pleura shining, coarsely rugose; abdominal dorsal segments long-clavate, black, with a silky lustre, 2 and 3 with a wide basal band of amber, a few scattered white hairs; ventral segments similar, with more long white hair.

Legs slender, amber, with large areas black, white hairs; tarsi amber, basitarsus slender and very long; claws reddish; hind calcar amber; tegulae amber; wings hyaline; nervures dark amber, first recurrent entering the second cubital at its distal corner; cells: the second cubital almost square, a trifle higher than long; pterostigma darker amber, and conspicuous; hamuli weak, six or seven.

Locality: Patonga, New South Wales; 26th Jan., 1947; Norman W. Rodd.

Type in the collection of the author.

Allies: Plainly in the *bicingulatus* group, and exceedingly near to the larger (10 mm.) *H. ziegleri* Raym., which it closely resembles.

These two bees resemble wasps in the genus *Trypoxylon*, for they have a slender, clavate abdomen.

The males were taken on flowers of *Leptospermum* sp.

Exoneura rufitarsis, sp. nov.

Type, female. Length, 6·5 mm. approx. Black, shining.

Head circular from the front; frons excavated round the bases of the antennae; clypeus flat, with a narrow sub-obsolete ivory line, a few lank white hairs; supraclypeal area rising to a fine carina that does not reach the median ocellus; vertex microscopically lineate; compound eyes converging below; genae microscopically lineate; labrum amber-coloured, coarsely punctured; mandibulae black; antennae black, scapes with a reddish dot basally, flagellum obscurely reddish beneath.

Prothorax not visible from above; tubercles ivory; mesothorax almost polished, with a delicate tessellation, a few white hairs; scutellum similar, postscutellum rougher; metathorax with a coarse scale-like sculpture in a more or less concentric pattern; abdominal dorsal segments black, hind margins depressed, a microscopic lineation, a few pale-straw coloured hairs; ventral segments polished, with a few pale hairs.

Legs black, a few white hairs; tarsi red; claws red; hind calcar reddish; tegulae piceous; wings dusky; nervures blackish-brown; cells: second cubital very wide, but contracted at apex; pterostigma blackish-brown; hamuli weak.

Locality: Cranbourne, Victoria; September, 1947; Owen Dawson.

Type in the collection of the author.

Allies: *E. atterrima* Ckll., which has entirely black face; *E. melaena* Ckll., also with a black face; and *E. nitida* Ckll., which has tergites narrowly reddened, and a broad clypeal band.

This female was taken in a dry stalk of "Wild Parsnip", in the pith of which she had excavated a three-inch chamber 3 mm. in diameter, and which contained three eggs attached horizontally to the lumen of the tube at intervals of about 5 mm. There was no trace of cell divisions, nor was there any pollen stored. The biology thus far follows the typical pattern.

Exoneura parvula perparvula, subsp. nov.

A large series of very small females from New South Wales are very close to *Exoneura parvula* Raym., but are distinct. They can be readily separated by the absence of the black bands on the abdomen, which is of a darker red colour, with a black macula laterally on tergite 2. The legs have more black, and there is very little red, even in the hair.

The head is larger than that of *E. parvula*, with a greater development of the genae. The antennae are short and stout, and there are no pale marks on the face, scutella or tubercles. These characters are very constant in the series.

It is extremely difficult to separate many of the adults in *Exoneura*, but the larvae show quite distinct characters, and until the communal nest is discovered and the larval appendages studied critically, I propose the subspecies *E. parvula perparvula* for these Bundeena females, which were taken at the same time and place as the species.

Locality: Bundeena, National Park, New South Wales; October, 1947; Alex. Holmes.

Type in the collection of the author.

Taken on flowers of *Eucalyptus* sp.

EXPLANATION OF PLATE XXI.

1. Front of head-capsule of male bee *Sphaerhylaeus bicoloratus*, sp. nov. Note the huge globose bicoloured scapes.
2. Front of head-capsule of bee *Sphaerhyaelus gibbonsi* (Ckll.).
3. Front of head-capsule of bee *Palaeorhiza hierogliphica* Raym.
4. Aciculate sculpture of clypeus.
5. The large convex "face" of *Euryglossimorpha ruficauda*, sp. nov., has the plates fused.
6. Punctate sculpture of mesothoracic disc.
7. Dorsal view of the short wide glossa.
8. Apical segments of flagellum of *E. nigra* Smith.
9. Dentate hind calcar of female *E. ruficauda*.
10. Bee, *Euryglossa rejecta* Ckll. opening the labellum of orchid *Caladenia filamentosa* subsp. *tentaculata*.
11. The genitalia of the male is not typical of the genus.
12. Group of olfactory ? pores at base of posterior wing.
13. Seventh tergite of the male.
14. Strigil of male.
15. Sensory hairs on anterior orbital margin of *Sphaerhylaeus gibbonsi* (Ckll.).
16. Microscopical sculpture of scapes of *Sphaerhylaeus bicoloratus*.

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POSTSCRIPT ON THE TRIGONALID PROBOSCIS, BY TARLTON RAYMENT, 12 JANUARY, 1948.

After the specific description had been set up by the printer, the author received from Norman Rodd a mounted preparation of the palpi of a female, and he was able to study these parts of the proboscis more critically. The basal segment of the maxillary palpus is excessively short, two and three quite as stout but much longer, four, five and six conspicuously slender.

The following measurements, in microns, are approximate: 1st seg., 185; 2nd, 400; 3rd, 425; 4th, 500; 5th, 425; 6th, 500. The labial palpus has only three conspicuous segments, but there appears to be an excessively short basal palpiger. The author is unable to work out the homologues from this mount of the mouth-parts, but the stipes appear to be short and stout, the galea exceedingly short; the pharyngeal rod spread at a wide angle; the pharyngeal plate short and strong.

OBSERVATIONS ON THRIPS.
WITH DESCRIPTION OF A NEW SPECIES.

By TARLTON RAYMENT, F.R.Z.S.

(Plates xxii–xxiii.)

In 1935, in my monograph, *A Cluster of Bees*, p. 488, I drew attention to the fact that I had found Thrips sheltering through the winter and feeding on the pollen-stores in the nests of certain wild-bees.

During the last week of July, 1946, I received yet another "nest" of a solitary wild-bee, a very small black one with pale yellow markings, *Hylaeus nubilosus mediostictus* Ckll. It contained larvae and pupae in transparent oval skin cells, of extremely delicate structure, and each of which measured some 11 mm. in length, with a diameter of 4·5 mm.

Seven cells were built in a tube excavated in a twig of Wattle, and were collected at Lane Cove, near Sydney, New South Wales, by Norman W. Rodd, who has sent many other interesting specimens. The nest is a typical one for the *Hylaeidae*, and in one gallery was the deserted skin cell of a bee, and which contained the remnants of the original pollen-pudding provided by the industrious honey-gatherer. In this cell were several large thrips feeding on the remnants of pollen, but all were at the wingless (apterous) stage. The specimens are of a distinctive form, and somewhat anomalous, since the six tarsi are each armed with a pair of claws. Moreover, the abddomen at this stage is white, with numerous reddish-brown maculae dotted over the surface.

In the gall-making genera, *Cladothrips* and *Phloeothrips*, the anterior feet are armed with strong claws. Froggatt, investigating one species of these, counted over 1,000 immature thrips, together with the mother, in a single gall.

The Lane Cove specimen should, perhaps, be regarded as the type specimen of a new species, and in this paper I shall refer it to *Cladothrips* and append the specific description.

More than 70 species of thrips are known in Australia, and the study of them is very important for the economic entomologist, since the insects constitute a serious menace to the economy of man, for vast hordes attack his crops and gardens and inflict heavy losses. Any contribution to our knowledge of the thrips is, therefore, to be warmly welcomed.

The habits of certain species are such that it is almost impossible to suggest any remedial measures which would be effective in controlling their numbers. It is obvious that no poison spray could possibly reach galleries excavated in dry trees and occupied by wild-bees. Ensconced in such protected havens, the thrips can rest and feast in peace on the pollen-stores of the bees.

I have discovered pest thrips sheltering from the heat of summer in the tightly-fitting sheaths of green grass stalks, and even there the insects would be effectively protected from poison sprays, since they suck the sweet juice out of the unexposed stems. Frankly, I do not believe that measures such as spraying will ever control thrips, for they cannot be effective in the field. The untold miles of Cape Weed, *Cryptostemma calendulaceum*, flourishing throughout Australia, constitute a vast feeding ground carrying unlimited amounts of pollen. It would appear that we can, therefore, abandon all thoughts of control by poison sprays and concentrate on discovering a fungus, a mould, a bacterium, or some other microscopic form of life that could be used as a biological control by infecting a number of thrips and then releasing them to infect others with which

they come in contact. That method, of course, connotes a much better knowledge of the biology of the thrips than we possess at the present day, and the phenomenon of parthenogenesis further complicates the problem. The time given by authors for the development from egg to adults varies in a striking manner—from a few days to several weeks.

Certain females have a serrated ovipositor to cut narrow channels in living vegetable tissue, and the minute, somewhat oval, eggs are inserted in the wounds, whence, later, the nymphs will emerge and immediately seek a hiding place in buds, leaf-sheaths, or any other close shelter that offers.

The young thrips of the remarkable *Kaleidothrips inquilinus* Kelly and Mayne* which I reared from the hollow stems of dock plants (a weed species of *Rumex*, in the family POLYGONACEAE) were coral-pink in colour, and at the apterous stage, but the young of some other species are colourless. The adults are winged.

The native thrips are frequently collected on the indigenous wattles, for Bagnell often mentions this association, and no doubt the abundant rich pollen of the *Acaciae* is a strong attraction. Strangely, the pest thrips are the species introduced from overseas.

The metamorphosis of thrips is incomplete, for the young ones bear a close resemblance to the imagines, although the wings do not appear until after the fourth and final moult. Not all species, however, have winged forms.

Hinds states that the life of a thrips does not exceed twelve months, but other authors assert that there are several broods each year, and it is well demonstrated that many generations are produced by parthenogenesis, that is, the females have the prerogative of reproducing the species without a copulation with the male, and this probably accounts for the fact that far more females than males are taken by collectors.

Thrips are in the order THYSANOPTERA,† with two sub-orders, TEREBRANTIA and TUBULIFERA, and the new species is included in the latter sub-order, since the apex of the abdomen terminates in a short tube, as will be seen from the illustrations. The species in the first sub-order all lack the tube-like segments, and the females have a curved ovipositor. There is but one family, PHLOEOTHRIPIDAE, in the TUBULIFERA.

The four narrow wings are closely fringed with long hair; the head is long and narrow, with two small compound eyes; two ocelli appear in the winged forms. Many of the species are only a millimetre or so in length, but *Idolothrips spectrum* Hal. is the largest, being nearly half an inch in length.

The new species, too, is a large one, and easily identified by the maculated white young ones; the long third segment of the antennae; the pair of huge claws on the anterior legs; and the great femora of the male.

Later, in November of the same year, Norman Rodd sent a beautifully complete series of this thrips containing numerous eggs, immature larvae at various stages, and adult males and females.

The insects were inhabiting twigs of a species of *Acacia* that apparently had been chambered by some other species. The sticks averaged 5 mm. in diameter, and the "bore" measured 3 mm. in diameter, the longest being 5 cm. Since the

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* In Kelly and Mayne's "Catalogue of Australian Thrips", 1934, my signature has been erased from the original plate of this species, and the initials "F.M." have been substituted for it—a piece of deliberate plagiarism rarely encountered in scientific work.—T.R.

† The bladder-like process of the normal foot is responsible for the alternative name, PHYSAPODA.

base of the lumen was closed with a thick wad of teased-out wood fibre, and the upper end with an iris of finer, more closely compacted material, the galleries probably had been excavated originally by one of the reed-dwelling bees in the genus *Exoneura*.

The numerous cylindrical white eggs are disposed in close but irregular order, and lack the beautiful hexagonal sculpturing of bees' eggs. They are just scattered masses on the walls of the lumen of the tube that had been reduced to a thin shell, a mere millimetre or two in thickness. The total number of eggs could not be ascertained, owing to the twigs being broken, but it must have been very large, since numerous females were present. The eggs measured 875 microns at the long axis and 300 microns at the short. The incubating period is unknown, but the eggs turn blackish just before the larvae emerge.

The very pale young ones have somewhat the appearance of Acarid mites, but as they develop become whiter and conspicuously maculated with madder-brown colour, as I have already described.

The adults, however, are jet black and shining, and the winged ones have the four sub-equal heavily-fringed wings of the genus. The most prominent feature of the apterous male forms are the huge anterior legs with the truly gigantic burrowing-claws of the gall-making *Cladothrips*. All the median and hind tarsi have the bladder-like organs of typical thrips. These are shown in Plate xxiii, fig. 14.

Norman Rodd has made many fine contributions to natural history by extending our knowledge of Australian thrips, while his valued collections of the "nests" and larvae of *Exoneurae* have clearly established the relationships of these fascinating Australian bees with the no less interesting *Allodape* of South Africa. Without his zealous assistance my taxonomic studies of these bees would have lacked the conclusive evidence afforded by the remarkable larvae.

It is a matter for regret that my attempts to rear the new species of thrips to the winged stage were not successful, but further efforts to do so will be made during the approaching summer. A synthetic pollen, which I compounded for the honey-bees of the commercial apiaries, is proving successful in rearing other pollen-eating insects.

Order THYSANOPTERA.

Suborder TUBULIFERA.

Family PHLOEOTHRIPIDAE.

Cladothrips punctatus, sp. nov.

(Plates xxii–xxiii.)

Female larva. Length, 3 mm. approx.

Head, prothorax, legs and tube blackish-brown, the abdomen white, with numerous reddish-brown maculae on each segment, from each of which issues a long strong seta; the head long and narrow. The third segment of the antenna is the largest, as in *Kellyia* and *Tetraceratothrips* Bagn., the minute seventh apical segment is distinct from the sixth.

Apical tube short, as in *Phaulothrips*, and fringed with long setae alternating with short curved ones, as in *Kaleidothrips inquilinus* Kelly.

All tarsi bear a pair of apical claws and a long seta, but the slender anterior tarsi and femora are unarmed, as in *Adiaphorothrips*.

The measurements in microns are approximate: width of abdomen, 750; length of head, 425; width, 189; total length of antennae, 1,000; segment one, 75; two, 140; three, 348; four, 189; five, 130; six, 70; seven, 48; length of two apical segments of abdomen, 600; length of tarsal seta, 70.

Type, adult female. Length, 5·5 mm.; width of abdomen, 1 mm. Black. Head, 1 mm. in length, is somewhat longer than the tube. Thorax 1 mm. long, the two sub-equal wings heavily fringed in the winged forms. Antennae as described for the maculated stage.

Abdomen elongate, each segment having two setae laterally. The tube is minutely and densely punctured; the apex having short curved setae alternating with much longer ones. The rest of the body is shining and impunctate.

Anterior tarsi with small claws in the female, but in the male the huge femora and claws are very distinctive.

Locality: Lane Cove, Sydney, New South Wales; July and November, 1946.

Collector: Norman W. Rodd, in "nests" of wild-bees built in dry twigs of *Acacia*.

Type specimens and co-types, mounted in "Euparel", in the collection of the author.

EXPLANATION OF PLATE XXII.

1. Dorsal view of larval *Cladothrips punctatus* Rayment. Note the maculated abdomen.
2. Apical segments of the abdomen showing the microscopic organs at "A".
3. Organ at "A" more highly magnified.
4. The third segment of the antennae is the longest.
5. The arrangement of the setae on the margin of the tube.
6. Each of the apical segments of the tarsi has a pair of hooks, and what appears to be an empodium and a seta, instead of the typical bladder-like organ.
7. The silvery skin cells of a Hylaeid bee, and in which the thrips were feeding.
8. Portion of the integument showing macula and seta.

EXPLANATION OF PLATE XXIII.

9. A twig of *Acacia* showing eggs on the lumen of the tube.
10. The large egg lacks sculpture on the chorion.
11. The young larval thrips has a pale abdomen.
12. The huge anterior legs and claws of the male.
13. Adult female thrips with heavily fringed wings.
14. Compare the huge claws of the male with the small ones of the female.
15. The tube of the female is finely and closely punctured; the rest of the body is impunctate and shining.

NEW SHARKS AND FISHES FROM WESTERN AUSTRALIA.

PART 4.

By GILBERT P. WHITLEY, F.R.Z.S.
(Contribution from The Australian Museum.)

(Plates xxiv–xxv and text-figs. 1–7.)

Family TRIAKIDAE.

FUR VENTRALIS Whitley, 1943.

(Figs. 1–2.)

Fur ventralis Whitley, Rec. S. Austr. Mus., vii, 1943, p. 397, and Austr. Zool., x, 1944, p. 259, fig. 5. Bunbury, W.A.

The Whiskery Shark was one of several new species of sharks encountered in Western Australia during investigations for the Division of Fisheries, Council for Scientific and Industrial Research. I measured and opened more than fifty freshly-caught specimens of which males and females were about equally represented. In 1943 and 1944 I saw about one hundred examples of *Fur ventralis* in the Perth Markets, where they comprised between 4% and 5% of the total sharks offered for sale. The departmental returns of the Fisheries Inspectors at Bunbury for the Bunbury and Busselton area specified Whiskery Sharks from 1943 onwards and show that a few examples are caught throughout the summer months, increasing if anything in October and November. *Fur ventralis* comprised 50% of the 1943 Bunbury Sharks caught (92 caught) whilst 187 (9%) were mentioned in the 1944 returns.

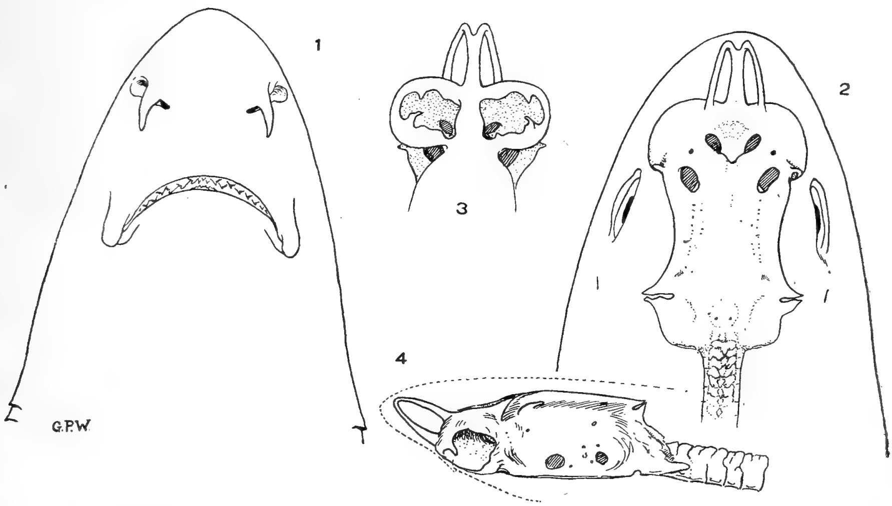

Fig. 1.—Whiskery Shark, *Fur ventralis* Whitley. Head and skull of a 19-lb. female from Two People Bay, Western Australia. No. 1, ventral surface. No. 2, dorsal surface with skull in situ. No. 3, ventral view of anterior portion of skull. No. 4, lateral view of skull.

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Fur ventralis occurs from Abrolhos to Esperance, Western Australia, and probably across the Great Australian Bight to South Australia, whence Waite has figured it as *Mustelus*, omitting the "whiskers" (nasal cirrhi) and anal fin.

The Whiskery Shark is caught on rough rock and weedy bottoms on setlines with baits of squid (*Sepioteuthis*) or fish; it also feeds on octopus and an occasional crayfish.

The dental formula varies from 11.1.12 to 15.1.16 over 36 to at least 42.

The head of a Whiskery Shark caught at Two People Bay in September, 1943, is figured here (fig. 1) to show the long nasal barbels and form of labial folds. Its dental formula was 11.1.12 over 36. The dorsal surface of the head, whose slight asymmetry is natural, is shown with the skull in situ. The ventral view of the anterior portion of the skull shows prolongations of the cartilages to support the nasal cirrhi, but generally the cranium resembles the Galeoid sharks.

In filleted specimens in the markets the myocommas show more prominently as darker grey chevrons than those of the Gummy Shark (*Emissola*). Both *Fur* and *Notogaleus* generally have a swerve in the lateral line behind the dorsal and anal fins.

For its size, the Whiskery is a heavy shark, females being generally heavier than males, as shown in Table 1.

TABLE 1.

Total Length in mm.	Length of Claspers in mm.	Weight in Lb.	
		Males.	Females.
905	—	—	6
1,063	—	—	9
1,080	—	—	10 to 11½
1,092	55	10½	—
1,100	—	—	13
1,130	35	9½	—
1,150	64	12 to 14	—
1,180 to 1,200	—	12	13½ to 17
1,230 to 1,240	—	—	16 to 20
1,250 to 1,270	70 to 80	18	16 to 19
1,280 to 1,290	—	16¾ to 18	18 to 20
1,300 to 1,310	80 to 90	18 to 21½	19 to 22
1,320	91 to 97	22	—
1,330	85 to 90	23 to 27	—
1,340 to 1,350	83	19 to 22	25
1,400	—	24	—

The proportions, with growth, are fairly constant in both males and females, as shown by a few measurements (Table 2).

TABLE 2.

Total Length in mm.	Head.	Interdorsal Space.	Upper Caudal Lobe.
905	170	210	175
1,063	195	265	200
1,080 to 1,100	200 to 207	270 to 280	190 to 205
1,150	200	290	215
1,193	225	300	210
1,230 to 1,250	232 to 235	280 to 330	220 to 230
1,260 to 1,290	234 to 238	323 to 333	225 to 236
1,300 to 1,330	245 to 253	300 to 355	222 to 250

The liver weighs from 2·7% to 4·5% of the total weight in most specimens, but as females mature it increases to 6·5 to 7·8, and in one mature male (1,250 mm. long) was 10·6%. Maturity in males (judged from length of claspers, differentiation of testes from mesorchium, and presence of sperm in the vesiculae seminales) occurs at about 1,300 mm. total length (claspers 80 or 90 mm.), though one of 1,350 mm. (cl. 80) was immature.

Females in the Albany district were maturing in September-October, 1943. The 1,240 mm. female, 19 lbs. in weight (fig. 1) from Two People Bay, 28 miles from Albany, September 26, 1943, had 6 large eggs up to 37 mm. in diameter in the ovaries, but the uteri were not developed. On January 15, 1944, in the Recherche Archipelago, a 1,180 mm. female, 17 lbs., had large ovarian eggs and 5 eggs, 80 × 30 mm. diameter, in each uterus. Others, 1,195 to 1,340 mm., at the same time were immature. From January 26 to February 3, 1944, in the Recherche Group, we caught:

(*a*) Female, 1,315 mm., 22 lbs., with 10 eggs, 70 × 30 mm., in each uterus.
(*b*) Female, 1,302 mm., 19 lbs., 6 to 8 eggs in each uterus, as in (*a*).
(*c*) Female, 1,305 mm., 22 lbs. Ovaries with small eggs, uteri undeveloped.
(*d*) Female, 1,200 mm., 16 lbs. Immature.

Off Bunbury on January 17, 1945, a 1,240 mm. female of 17 lbs. had 12 eggs, 40 mm. in diameter, but no embryos.

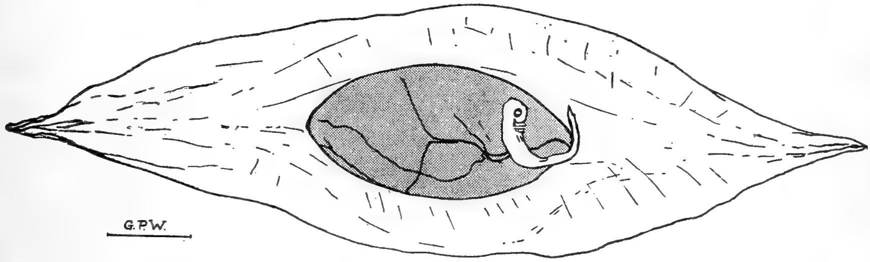

Fig. 2.—Whiskery Shark, *Fur ventralis* Whitley. One of eleven embryos from a 15-lb. female, Bunbury, Western Australia. Membranous envelope 10 inches long. Semi-diagrammatic.

G. P. Whitley del.

The first pregnant specimen discovered was a 1,198 mm. (15 lbs.) female caught off Bunbury, March 1, 1945, so that the species evidently first breeds at about 1,200 mm. This had 11 embryos, 30 to 45 mm. long, with external gills and yolksacs 76 to 95 mm. by 33 to 40 mm. (fig. 2). Each embryo with its yolk occupied a separate, thin-walled compartment, as in *Galeolamna dorsalis*, *G. greyi* and its subspecies, and probably *Emissola antarctica*, but the walls are thin and easily torn or overlooked. In the White-spotted Gummy, *E. ganearum*, the embryos are not separated by compartments within the uterus.

On March 21, 1945, a 1,295 mm. female *Fur* had ova up to 60 mm. in diameter in the ovary, and 9 uterine ova and 9 embryos, 17 to 30 mm. long; uterine yolksacs 85 × 35 mm. diameter. Unfortunately I had to leave the district before studies on embryonic growth could be made, and the size of full-term embryos is unknown.

Stages of a Shark.

For field purposes the following stages in the development of a Shark (or Ray) may be useful when tabulating data towards life-histories:

A. Egg.

B. Embryo. – IV. Primitive streak or undifferentiated to naked eye.
– III. Recognizable as a shark, external gill-filaments present.
– II. Recognizable as to genus, absorbing yolksac; gills absorbed.
– I. Full-term embryo, yolksac absorbed or nearly so.

C. Born. 1. Newly born "pup".
2. Juvenile, umbilical scar still present. Different ones may be born at different sizes and some grow quicker than others.
3. Growing immature stage. Gonads small or strip-like, ova and testes not differentiated.
4. Adolescent or virgin. Gonads differentiating from mesovarium or mesorchium; ova small, uterus a mere thin tube.
5. Adult. Sperm can be expressed from vesiculae of male. Uteri enlarged in females, bearing embryos in season and/or ovaries with large eggs.

The time elapsing from one stage to the next varies considerably in different species of sharks, and many more observations will be necessary before outlines of the life-histories of even the commonest species can be sketched. Readers are asked to record lengths and sexes of all sharks seen, with numbers, sexes and lengths of embryos, with localities and dates, being particularly careful regarding the identification of the species, for which purpose at least the head of the shark should be sent to a museum.

Family Sphyrnidae.

Sphyrna lewini (Griffith, 1834).

(Plate xxiv and text-figs. 3–4.)

In my "Fishes of Australia" (1940, p. 120) I mentioned that there seemed to be only one species of Hammerhead Shark in Australasia, but that further study of more specimens was desirable. Though I am still unable to recognize more than one species, the field notes and figures given below, made during investigations for the C.S.I.R., Division of Fisheries, from freshly-caught Queensland and Western Australian specimens, may be of interest to students and can be compared with recent studies on American Hammerheads by Springer (Proc. Calif. Acad. Sci., iii, 1938, pp. 30 and 38, figs. 15–17, *et ibid.*, v, 1940, p. 46, figs. 1–6; Stanford, Ichth. Bull., i, 1940, p. 161, figs. 1–7) and with the account of the skull by Lloyd and Sheppard (Proc. Zool. Soc. Lond., 1922, iv (1923), p. 971, figs. 1–7).

Specimen 1 (Pl. xxiv, fig. 3). Young, immature female, 507 mm. long. Wt. $2\frac{1}{8}$ lbs. Connor's Creek, Fitzroy River estuary, Queensland; March 22, 1943. Head four-lobed in front. Anal origin slightly before that of second dorsal. Lower caudal pit obsolescent. Second and third gill-slits deepest. Small quantity of mud and grit in stomach.

Life-colours: Upper surface pale grey with metallic iridescence, pinkish-bronze. Margins of hammer and ventral surface white. Second dorsal and upper and lower caudal lobes tipped with smoky grey. Lower caudal lobe black-tipped. Eye dirty greyish with pale green tinge. (Biometrics, see Table 4 below.) Side of head at end of hammer, 49·5 mm.

Specimen 2 (Pl. xxiv, fig. 1, and text-fig. 4). Immature female, 1,152 mm. Wt. 13 lbs. Off Bald Head, Albany, Western Australia; September 11, 1943. Austr. Mus. regd. no. IB.1647. Dental formula 14.1.14 over 13.1.13. Teeth each side of symphysis of lower jaw erect, others sloping, not denticulate, notched deeply on outer slopes. Second to fourth gill-slits subequal, 39 mm. Eye to end of hammer, 58.

Thin lateral line visible. No interdorsal ridge. A deep upper and a rudimentary lower caudal pit. Lobes of second dorsal and anal not nearly reaching caudal pits as in Fish. Austr., i, 1940, fig. 128. Origin of first dorsal behind level of inner angle of pectoral, above posterior lobe of latter. Lower caudal lobe acutely rounded. Anal larger than second dorsal and more advanced. Three digested pilchards (*Clupeidae*) in stomach.

Ovaries quiescent; uteri slim and undeveloped. Liver, ½ lb. wt.

Life-colour: Light slate-grey above, white below. Eye bluish-grey. Nictitating membrane milky-white, not brown. Trenchant anterior edges of all fins dusky greyish. Posterior caudal and anal fin margins dusky grey. Creamy yellow margin to front and sides of head. (Biometrics, see Table 4.)

Specimen 3 (text-figs. 3 and 4). Very immature male, 1,506 mm. Wt. 36 lbs. West of Station Island, Recherche Archipelago, Western Australia; January 15, 1944. Claspers, 33 mm. Side of head, 102 mm. Third gill-opening longest. Second dorsal with long posterior lobe. Slate-grey above. Parchment white below. Fins dusky above. Anal and caudal with blackish tip and edges respectively. Eye dark blue with brownish-grey iris. Stomach contained a very digested squid. (Biometrics, see Table 4.)

Specimen 4. Immature male, 770 mm. Wt. 6 lbs. Off Second Beach Point, Esperance, W.A.; January 29, 1944. Claspers, 14 mm. Umbilicus healed. Stomach contained pilchard.

Specimen 5 (Pl. xxiv, figs. 2, 2*a–b*). Very young female, 600 mm. Same loc. and date. Umbilicus open. W.A. Mus. no. P.2592.

Specimen 6. Very young male, 612 mm. Wt. 1 lb. 13 ozs. Same data.

Specimens 7 to 15. Nine very young specimens, 4 males with 10 mm. claspers, and five females, from between Charley Island and Burton Rock, Esperance, W.A.; February 10, 1944. Umbilical scar in all. (See Table 3.)

TABLE 3.

Length.	Width of Head.	Weight.	Sex.
mm.	mm.	lb. oz.	
560	158	1 8	♂
600	162	1 10	♂
602	160	1 15½	♂
604	161	2 1	♀
608	160	1 14	♀
620	168	2 1	♀
630	171	2 3	♀
642	178	2 3	♂
675	178	2 8	♀

Liver weight about 3% total weight.

Specimen 16. Immature male, 630 mm. Wt. 2 lbs. Bunbury, Western Australia; January 17, 1945. Width of hammer, 170; claspers, 14; interdorsal space, 154 mm.

Specimen 17. Young male, 712 mm. Wt. 3½ lbs. Bunbury, W.A.; March 2, 1945. Hammer, 195; head and body, 510; upper caudal lobe, 202; interdorsal, 187; clasper, 15 mm.

Specimen 18. Young female, 615 mm. Wt. 2½ lbs. Bunbury, W.A.; March 2, 1945. Hammer, 178; head + body, 480; upper caudal lobe, 195; interdorsal, 183 mm.

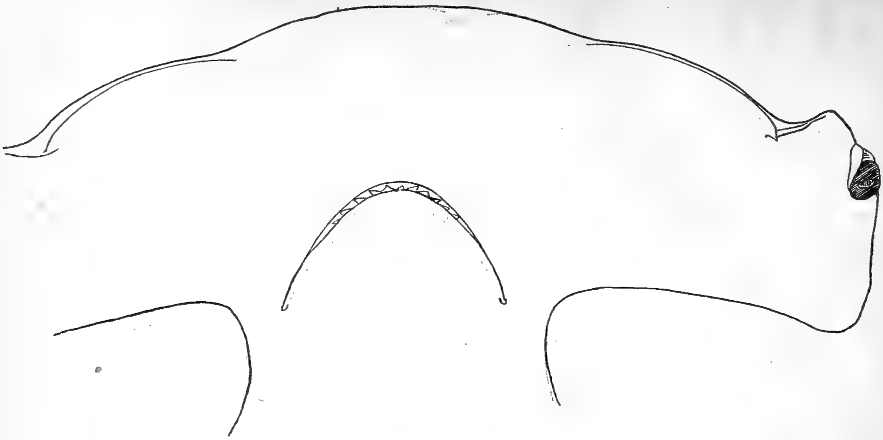

Fig. 3.—Hammerhead Shark, *Sphyrna lewini* (Griffith). Head of male from Station Island, Recherche Archipelago, Western Australia (Specimen no. 3). Width of hammer, 16¾ ins.

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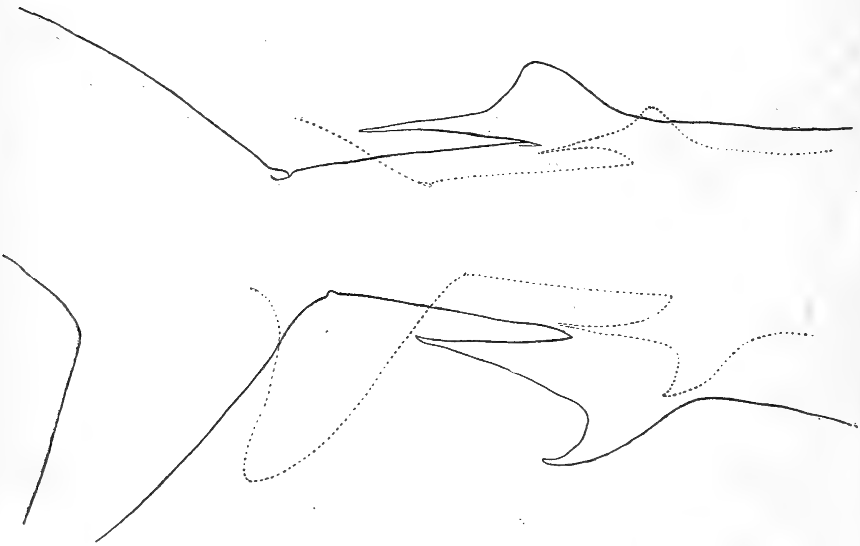

Fig. 4.—Hammerhead Sharks, *Sphyrna lewini* (Griffith). Relationships and proportions of second dorsal, anal and caudal fins in specimens no. 2 (dotted line) and 3 (solid line); about one-third natural size.

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Specimen 19. Male, about 9 ft. long. Wt. about 4½ cwt. Fremantle, W.A.; November 26, 1929. Hammer, about 23 by 7 inches. W.A. Mus. no. P.998.

Messrs. Joyce and Watkins, of Fremantle, W.A., kindly made available their returns from the Shark Fishery of June, 1935, to March, 1936, operating from Fremantle to Rockingham. Seventeen hammerheads were caught, 3½ to 11¾ ft.

long. The smallest weighed 17 to 18 lbs., a 4ft. 10 in. specimen weighed 30 lbs. but the others were not recorded. Judging from specimens seen, the reports of Fisheries inspectors and fishermen, and the commercial returns, the Hammerhead Shark is caught off south-western Australia in winter and summer, but mostly in from October to March. Growth after birth is evidently rapid, since specimens nos. 7 to 15 all had umbilical scars, yet no. 4, 770 mm. long, obviously a first-year shark, had the scar healed. The tables below indicate rapid growth in several directions. Data are, however, too scattered and incomplete for any deduction or adumbration of the life-history of this extraordinary Australian shark.

Biometric data for the first three specimens, following my scheme propounded in Proc. Linn. Soc. N.S. Wales, lxviii, 1943, p. 114, are as shown in Table 4.

TABLE 4.

—	Specimen.		
	1 Q.	2 Albany, W.A.	3 Recherche, W.A.
H. 1	90	180	240
2	122	247	358
3	76·5	154	214
4	136	289	373
5	118	238	313
6	228	510	694
7	13	22·5	26
8	12·5	18	21
9	137	300	407
10	—	—	—
11	32	24+	104
12	67	227	164
13	37	64	78
14	34	72	99
15	2	Deep notch	c. 1
16	c. 1·5	,,	4
17	15	25	38
18	14	24	29
B. 1	351	815	1,054
2	245	544	717
3	155	323	403
4	64	155	211
5	38·5	c. 110	140
6	24	43	62
7	14	37	50
8	Nil	Nil	33
9	,,	,,	33
F. 1	78	166	229
2	49	109	146
3	24	34	50
4	108	308	400
5	18	40	48
6	18	35	44·5
7	27	54	78
8	37	92	114
9	24	61	78
10	24	49	64
11	19	51	69
12	32	94	112
13	—	—	—
14	62	128	190
15	25	58	78
16	119	288	369
17	26	43	63
18	24	50	74
19	14	30	42·5
20	60	150	192
21	161	344	444
22	58	134	184

Family CLUPEIDAE.

Genus MACRURA van Hasselt, 1823.

MACRURA BLACKBURNI, sp. nov.

D.2, 16; A., 21; P., 16; V., 8; C., 18. Sc., *c*.36. Tr., 12. Predorsal, *c*.11. Scutes, 18 + 10.

Head (29 mm.) 3·6, depth (37) nearly 2·9 in standard length (107). Eye (10) 2·9, interorbital (7) 4·1, maxilla (14) 2, and depth of caudal peduncle (13·5) 2·1 in head.

Maxilla reaching below front of eye (or middle in smallest paratype), and denticulated. Upper jaw with slight notch at symphysis. A row of teeth in each jaw, six or more on each mandible; none on palate. Opercles venulose, without grooves. Eyelids broad. Occiput and scapula venulose. About 40 gill-rakers on lower limb of first gill-arch.

Body deep, abdominal profile very convex. Scales with ragged edges and completely crossed by about six grooves.

Origin of dorsal much nearer snout than root of tail. Last two anal rays not enlarged. Pectorals less than head. Ventral origin below middle of dorsal base. Caudal lobes slightly longer than head.

General colour in formalin yellowish, lighter on fins. Three to five dark brown stripes, which may be broken into rows of small marks, along top of sides. Eye bluish. A yellow flange below anterior gill-filaments. Snout, dorsal and caudal fins described as bright yellow in life. Dorsal and caudal lobes conspicuously black-tipped; other fins plain.

Described from the holotype, 107 mm. in standard length, or 5½ inches overall (Austr. Mus. no. IB.2010), the largest of seven specimens.

Locality.—Port Hedland, Western Australia; collected by A. E. Clark in January, 1943 (holotype and 5 paratypes), and by L. G. Smith, 24 October, 1941 (paratype). Nos. IB.2009 to 2115. Mr. Smith also obtained four other specimens which were dissected by Mr. M. Blackburn, who found 41 vertebrae, counting the urostyle.

Variation: D., 18–19; A., 19–21; P., 15–16; Scutes, 17–18 + 10–12. Gill-rakers, 12–18 + 38–40.

Rather like *Clupalosa lippa* (Whitley, 1931) but deeper in body and with strongly marked pattern, different scutes, etc. Differs from *Macrura koningsbergeri* (Weber & Beaufort, 1912) in having more predorsal scales and fewer body scales, also in coloration; similarly from *M. maccullochi* (Whitley, 1931) and notable for its toothless palate. The conspicuous black tips to the caudal fin are characteristic of *blackburni*. Similar to *hypselosoma* (Bleeker, 1855) but with larger scales.

Named in honour of Mr. Maurice Blackburn of the C.S.I.R. Division of Fisheries in recognition of his work on the bionomics of Australian Clupeoids. Mr. Blackburn discovered that this species was new but generously placed his specimens and notes at my disposal so that the species could be described for inclusion in my proposed "Fishes of Australia".

Family ENGRAULIDAE.

SCUTENGRAULIS HAMILTONII (Gray, 1830).

A specimen of this anchovy, nearly 4¼ inches long, was obtained at Port Hedland in January, 1943, by Mr. A. E. Clark. It has D.i, 14; A., 40; Sc., 44; and Scutes, 17 + 10.

New record for Western Australia.

Family Clupanodontidae.

Fluvialosa paracome, sp. nov.

D., 14; A.ii, 19; P., *c*.14; V.i, 7; C., 17. Sc., 35 to hypural. Tr., 13. Predorsal sc., 13. Scutes 16 + 11 = 27.

Head (30 mm.) 3·2, depth (42) 2·3 in standard length (97). Eye (9) 3·3, snout (5) 6, interorbital (8·5) 3·5 in head. Dorsal filament, 26 mm.

Cleft of mouth obtuse, reaching below front of eye. A symphysial notch. Dentary laterally reflected. No teeth apparent in jaws. Suborbital, upper opercles and humeral region venulose. Interorbital broadly convex. General facies as in the genus.

Body ovate, compressed, covered with cycloid scales with 8 basal striae.

Dorsal origin slightly in advance of level of ventral origin. Distance from ventral to anal origins less than head. Anal rays rather long, not forming pronounced anterior lobe.

General colour in alcohol, silvery-yellowish with the back brown. Eye surrounded with dark blue ring. A smoky-bluish, indistinct bar arises from eye and runs to nape, where it joins its fellow from the other side. Rows of thin lines along junctions of scale rows. No humeral blotch or only faint duskiness. Lobes of dorsal and caudal infuscated.

Described from the holotype, 97 mm. in standard length, L.C.F. 110 mm., or 5 inches in total length. W.A. Mus. regd. no. P.2619.

Locality.—Noonkanbah, Fitzroy River, Western Australia; Mr. W. W. Henwood, 1944. Distinguished from other species by having no humeral blotch, dorsal filament shorter, fewer predorsal and lateral scales, and notable for the depth of the body, height of anal fin, and the head longer than distance between ventral and anal origins.

Fluvialosa bulleri, sp. nov.

D., 14; A., 23; P., *c*.13; V.i, 7; C., 18. Sc., 39 to hypural. Tr., 16. Predorsal sc., 15. Scutes 17 + 12 = 29.

Head (29 mm.) 4·1, depth (52) 2·3 in standard length (120). Eye (8) 3·6, snout (6) nearly 5, interorbital (8·5) 3·4 in head. Dorsal filament, 34 mm.

Cleft of mouth barely reaching below front of eye, which is not much covered by adipose lids. General characters as in *Fluvialosa* spp.

Body very deep and compressed. Scales without basal radii. Dorsal origin slightly in advance of level of ventral origin. Head notably less than distance from ventral and anal origins. Anal rays forming anterior lobe.

Colour in formalin brownish yellow, darker over back and viscera. Eye dark blue. Vertex dusky but no smoky bar over eye. A thin reddish line from humeral region to middle of caudal peduncle probably overlay a lateral silvery band. A small humeral blotch? Lobes of dorsal and caudal slightly fuscate.

Described from the holotype, 120 mm. in standard length, L.C.F. 127 mm., or nearly 6 inches overall. W.A. Mus. regd. no. P.2945.

Locality.—Ord River, Western Australia; Mr. Ken. Buller, 1945. Distinguished by its small head, very deep body, lobed anal fin, long ventrals, etc.

These two species were listed as A and B in *W.A. Naturalist*, i, 1947, p. 53.

Family Plotosidae.

Tandanus bostocki Whitley, 1944.

(Plate xxv, fig. 1.)

Tandanus bostocki Whitley, Austr. Zool., x, 1944, p. 260. Serpentine, W.A.

Here figured from the holotype.

Family Syngnathidae.

Genus Corythoichthys Kaup, 1853.

Kaup's original introduction of this generic name was in Wiegmann's *Archiv für Naturgeschichte*, xix, 1, 1853, p. 231, where it was based on five nominal species. Most of the names of these were *nomina nuda*, the only two valid ones being *C. fasciatus* (Gray) and *brevirostris* (Ruppell), and one of these two must be designated genotype. Previous authors have chosen *albirostris* (a *nomen nudum ex* Heckel MS.) or even *conspicillatus* Jenyns (not listed by Kaup) as genotype, but their choices cannot be maintained. If we select *fasciatus* as genotype, *Bhanotichthys* Parr (Bull. Bingham Oceanogr. Coll., iii, 4, July, 1930, pp. 27, 29 and 142) will fall as a synonym of *Corythoichthys*, with the same type. If we pick *brevirostris*, then *Micrognathus* Duncker (Jahrb. Hamb. Wiss. Anstalt, xxix, 1912, p. 235; not *Micrognathus* Kaup, 1853, *ex* Kuhl and van Hasselt MS., an overlooked *nomen nudum*!) will fall similarly. As *Bhanotichthys* is of more modern introduction (1930) than *Micrognathus* (1912), I now formally designate *Syngnathus fasciatus* Gray, 1830 (*non* Risso) as genotype of *Corythoichthys*, of which *Bhanotichthys* has already been regarded as an indirect synonym by Herald.

Genus Hippichthys Bleeker, 1849.

Hippichthys Bleeker, Verh. Batav. Genootsch., xxii, 1849, Ichth. Faun. Madura, p. 15. Haplotype, *H. heptagonus* Bleeker (= *Syngnathus carce* Hamilton-Buchanan).

Ichthyocampus Kaup, Arch. Naturg. (Wiegmann), xix, 1, 1853, p. 231; Cat. Lophobr. Fish. Brit. Mus., 1856, p. 29. Logotype, *Syngnathus carce* Hamilton-Buchanan.

Weber and de Beaufort (Fish. Indo-Austr. Archip., iv, 1922, p. 92), with access to a specimen of *heptagonus* Bleeker, included it in the synonymy of *carce*; therefore the generic synonmy given above naturally follows. *Hippichthys* has hitherto been used for "*Corythoichthys*"-like pipefishes, and for species of *Parasyngnathus*.

Genus Parasyngnathus Duncker, 1915.

Parasyngnathus Duncker, Mitt. Naturh. Zool. Mus. Hamburg, xxxii, 1915, pp. 14 and 79. Orthotype, *Syngnathus argyrostictus* Kaup, 1856, from Java.

Parasyngnathus gazella (Whitley, 1947).

(Fig. 5.)

Hippichthys gazella Whitley, Austr. Zool., xi, 1947, p. 148. Broome, W.A.

D., 28; A., 2; P., c.14; C., 7. Rings 16 + 38. Subdorsal rings 0 + 6.

Head (nearly 11 mm.) longer than dorsal base (7) and more than 7 in total length (79). Eye, 1·5 mm.; snout, 5; postorbital, 4·5; depth, 3; caudal, 2·3. Tail, 1½ times head and body.

Supraorbital ridges not continuous with the long, low, wafer-like, entire rostral ridge. Interorbital very concave.

Operculum crossed by a straight keel with radiating striae, not serrated. Above this is a secondary, obliquely ascending ridge. Gill-openings small, superior. Eyes not bulging. Snout somewhat elevated. Three entire nuchal crests.

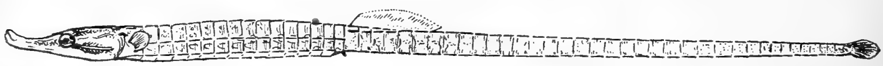

Fig. 5.—Pipefish, *Parasyngnathus gazella* (Whitley). Type from Broome.
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Body deeper than broad, seven-angled; ventral carina present; tail four-angled. Interstitial scutes present. Dorsal ridges of body ending below posterior dorsal rays, discontinuous with upper tail-ridges, which begin under origin of dorsal fin. Median ridges ending unconnected on last body ring. Lower ridges of trunk and tail continuous (Fig. 8 of Duncker's scheme). No knobs or conspicuous spines. Vent slightly in advance of dorsal origin, well within anterior half of fish. No broodpouch in the type, but probably subcaudal. Dorsal base not elevated, less than head-length.

Colour in preservative, pale brownish with light and darker mottlings and indistinct ocelli. An irregular Y-shaped dark brown mark along head forming a broken band along snout, dividing at eye and branching above and below opercular keels. A notched median brown band along each side of body. No pattern on throat. A small dark mark on each side of ventral surface of head below eye.

Described and figured from the unique holotype, a specimen 79 mm., or $3\frac{1}{8}$ inches, long.

Locality.—Broome, Western Australia; W.A. Mus. regd. no. P.2871.

Mainly distinguished by the ring-formula, 16 + 38, and rather short snout, in which particulars it differs from *Syngnathus argyrostictus* Kaup, 1856, the Javan genotype, and *S. poecilolaemus* Peters, 1869, from South and South-Western Australia. Apart from more tail-rings, the types of eastern Australian *Parasyngnathus altirostris* (Ogilby) have deeper snout, black band along chin and interorbital flatter.

I am indebted to Mr. L. Glauert, Curator of the W.A. Museum, Perth, for the loan of the holotype of *gazella* and for examples of the species described hereunder.

Genus Yozia Jordan and Snyder, 1901.

Yozia Jordan and Snyder, Proc. U.S. Nat. Mus., xxiv, 1901, pp. 5 and 8. Orthotype, *Y. wakanourae* J. and S. (= *Syngnathus bicoarctatus* Bleeker).

Yozia bicoarctata brevicauda (Castelnau, 1875).

(Fig. 6.)

Syngnathus bicoarctatus Bleeker, Act. Soc. Sci. Indo-Neerl., ii, 1857, p. 99. Amboina (*fide* Weber and Beaufort, 1911).

Syngnathus zanzibarensis Gunther, Fishes of Zanzibar (Playfair), 1866, p. 140, pl. xx, fig. 5. Zanzibar.

Syngnathus brevicaudus Castelnau, Res. Fish. Austr., 1875, p. 48. Swan River, W. Australia.

Ichthyocampus maculatus Alleyne and Macleay, Proc. Linn. Soc. N.S. Wales, i, March, 1877, p. 353, pl. xvii, fig. 2. Darnley I., Torres Strait, Queensland. Type in Macleay Museum, Sydney.

Yozia wakanourae Jordan and Snyder, Proc. U.S. Nat. Mus., xxiv, 1901, p. 8. Wakanoura, Japan.

Syngnathus coarctatus Jordan and Snyder, *loc. cit.*, p. 8. Error for *S. bicoarctatus* Bleeker.

Yozia brevicaudis Duncker, Jahrb. Hamburg Wiss. Anst., xxxii, 1915, p. 109.

Yozia bicoarctata Duncker, op. cit., p. 107. *Id.* Weber and Beaufort, Fish. Indo-Austr. Archip., iv, 1922, p. 101, fig. 42.

Yozia bicoarctata erythraeensis Dollfus and Petit, Bull. Mus. Nat. Hist. Nat. (Paris), (2) x, 1938, p. 500. Golfe de Suez.

Yozia bicoarctata melanesiae Fowler, Proc. Acad. Nat. Sci. Philad., 97, 1945, p. 61, figs. 3–4. Saipan.

Two specimens, which I identify as this subspecies, have been kindly lent by Mr. Glauert, who collected one of them at Cottesloe (W.A. Mus. regd. no. P.1231), a beachworn specimen, with fins eaten away, which had probably floated down from the tropics. The other example (no. P.964) was from Hanover Bay in the Kimberleys, presented by Mr. Deutschmann. The latter specimen is larger and more complete and is described below with notes on the differences between the two when such occur.

D., 26; A., 4; P., left 16, right 17. Caudal rudimentary in P.964 (double with 12 rays and little more than eye in length in P.1231). Rings 23 + 46 (or 20 + 39 in P.1231). Subdorsal 3 + 2.

Head (30 mm.) 12·9, depth at dorsal origin (8) 48·5 in total length (*c.* 388). Snout, 16 mm.; eye, 4; postorbital, 10; interorbital, nearly 4.

Head longer than dorsal base. Axis of head at an obtuse angle to that of body. Surface of head and body with fine rugae which form vertical striae on parts of lateral scutes. Snout as broad as deep. Forehead ascending from snout at an obtuse angle. Orbits apparently not prominent. Interorbital flat across sunken area between orbital bevels. No rostral crest, merely a short, slight ridge anteriorly. Head about 13 to 19 in total length, about $2\frac{1}{2}$ to $3\frac{1}{2}$ in trunk. Operculum without keel but with radiating pits and pimples sometimes forming streaks or reticulations and rough-surfaced. A prenuchal and two nuchal shields, without ridges. Gill-openings crescentic, close together, near back. Form very elongate. Trunk swollen in middle in P.964, but not in P.1231. Body six-angled, without ventral carina, slightly deeper than broad, not dilated. Tail four-angled, wider than deep, at least anteriorly. Interstitial scutella well developed. Body-ridges weak, without spines. Superior ridges of trunk converging towards end of dorsal base, discontinuous with superior ridges of tail, which end supero-laterally

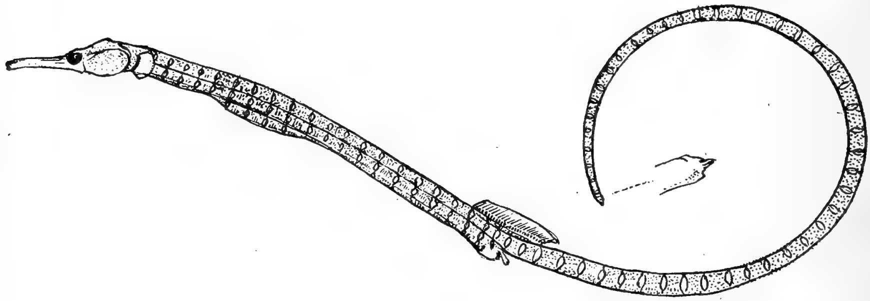

Fig. 6.—Pipefish, *Yozia bicoarctata brevicauda* (Castelnau). Specimen with reduced caudal fin from Hanover Bay.

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on second subdorsal ring. Median ridge of trunk descending below dorsal fin to join inferior ridge of tail, which is discontinuous with inferior ridge of trunk (similar to no. 5 of Duncker's scheme). No broodpouch in my specimens, though this would probably be abdominal. Soft area before vent swollen and bulbous in P.964 with few scutella anteriorly; normal in P.1231. Vent well before middle of length.

Base of dorsal fin elevated. Caudal fin present, though missing through injury or rudimentary in P.964, but in P.1231 there appear to be two caudal fins side by side with a total of 12 rays. It seems likely that the tail of this species may be bitten by other fishes and possibly regenerated after injury, which may explain the variety in number of tail-rings.

Colour in formalin, pale straw. Eye blue. A reddish-brown spot below base of each pectoral and dorsal ray.

Trace of a brown streak near back on right side of P.1231 at joints of 4th, 9th and 14th body rings.

The absence of an opercular keel is noteworthy, and the low number of subdorsal and tail-rings. Otherwise close to *Y. bicoarctata* (Bleeker), as described by Weber and Beaufort, 1922. In view of the likelihood of the tail being damaged and regenerated in these pipefishes, I consider that *brevicauda* Castelnau is the first valid name for the Western Australian subspecies. *Ichthyocampus maculatus* Alleyne and Macleay is evidently a synonym of *bicoarctata*.

Histiogamphelus meraculus, sp. nov.

D., 25; A., 3; P., 13; C., 10. Rings 21 + 36. Subdorsal rings 4 + 4. No broodrings, thus female. Head (26 mm.) 3·7 in length of trunk (97) or 8·6 in total length (225). Eye (4) 3·7 in snout (15), which is 1·7 in head and much longer than postorbital (8). Depth of snout nearly 4 mm. Trunk 1·3 in tail (128). Caudal length (6) 2·5 in snout. Pectoral length, 4 mm. Depth below dorsal fin, 5·5 mm., more than width (4·9).

Rostral ridge almost horizontal behind lips and with a slight dip over its anterior half and extending backwards to the reticulated interorbital. Supraorbital ridges practically merged with sides of rostral ridge. A prenuchal and two nuchal scutes, not joined to rostral crest. No median dorsal ridge. A short, obsolescent opercular keel anteriorly and nearly 40 radiating striae. The ridge defining the upper margin of the snout below the rostral crest slopes gently down towards level of middle of eye. The suparorbital ridges break the profile.

Dorso-lateral body-ridges ending on each side of dorsal base, on third tail-ring, not continuous with dorso-lateral tail-ridges which extend to upper part of last body ring, over but separate from the free end of the median body-ridge. Ventrolateral ridges of body continuous with inferior tail-ridges. Ventral carina along trunk. Thus corresponds with no. 9 of Duncker's scheme.

Dorsal base elevated anteriorly, less so posteriorly. Rays 25. Anal very small. Caudal probably lanceolate originally but median rays may be damaged so that it is now truncate.

Colour light brown, darkest in tone on back and body; no large dark blotches. Some nondescript light and dark markings on head and body and series of small light ocelli on lower parts of sides, one to each ring anteriorly, several to each ring along tail. Ridges yellowish with rows of small dark marks. Eye bluish above, silvery greenish below. Dorsal base dusky, its fin-rays reddish. Pectoral brown. Caudal dark grey to blackish centrally with whitish ends to upper and lower rays.

Described from the holotype, a dried specimen, 225 mm. or 8⅝ inches long, kindly lent for the purpose by Mr. L. Glauert, Curator of the Western Australian Museum, Perth, where the specimen is registered no. P.1215.

Locality.—City Beach, near Perth, Western Australia; Mr. John Kirk.

Distinguished from its congeners by the form and proportions of the snout and adjacent parts, the extent of the rostral crest, absence of mid-dorsal ridge, etc. It is nearest *H. briggsii* McCulloch, 1914, the genotype, but has longer and slenderer snout, head less than 4 in trunk, and different head proportions.

Family Mugilidae.

Oxymugil, gen. nov.

Orthotype, *Mugil acutus* Cuv. and Val., as identified below.

Snout acutely pointed from lateral view. Interorbital flat. Nostrils not close together. Adipose eyelids well developed. No fleshy lobes at sides of mandible.

No papillae on lips. Upper lip of moderate thickness, very slightly exceeded by the terminal, thin-edged lower lip, which is not folded downwards. No teeth or cilia on jaws. A symphysial knob in lower jaw. Scales ciliated on head, cycloid on body.

Marine, tropical.

Similar to *Mugil* Linnaeus, 1758, but snout more acute and has preorbital edge arched and denticulate, its posterior edge greater than space between nostrils and reaching past front of eye; 9 or 10 anal rays, predorsal profile straight. Distinguished from other mullet genera by the combination of the characters mentioned above.

OXYMUGIL ACUTUS (Cuv. and Val., 1836).

(Fig. 7.)

Mugil acutus Cuvier and Valenciennes, Hist. Nat. Poiss., xi, July, 1836, p. 140 "New Holland" (Péron).

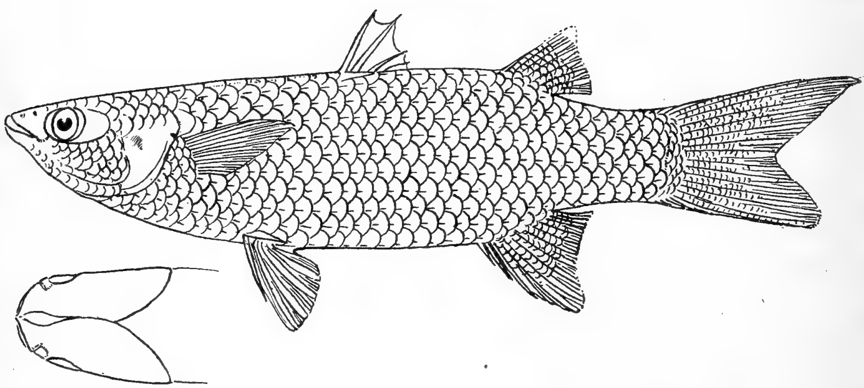

Fig. 7.—Sharp-nosed Mullet, *Oxymugil acutus* (Cuv. and Val.). A specimen from Broome.

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Here illustrated from a Broome specimen (W.A. Mus. regd. no. P.2400) which has the following characters in addition to those defined for the genus: D.iv/i, 7 (8); A.iii, 10; P., 13; V.i, 5; C., 12. Sc., 29 to hypural. Predorsal scales *c.* 17. Tr., 13 on body to 7 on caudal peduncle. Ten preventral scales. Maxillary hidden when the mouth is closed. No pectoral axillary scale. Body scales extending over fins (except pectorals and parts of ventrals). Colour, in formalin, straw-brownish with about a dozen longitudinal dark streaks along centres of scale-rows. Total length, 8 inches.

Family EPINEPHELIDAE.

EPINEPHELUS CHLOROSTIGMA (Cuv. and Val., 1828).

Serranus chlorostigma Cuv. and Val., Hist. Nat. Poiss., ii, 1828, p. 352. Seychelles.

One specimen, 10¾ inches long, from Port Hedland, was received from the Western Australian Fisheries Dept. in 1913. Austr. Mus. regd. no. I.12952.

New record for Australia.

EPINEPHELUS RANKINI Whitley, 1945.

(Plate xxv, fig. 2.)

Epinephelus rankini Whitley, Austr. Zool., xi, 1945, p. 24. Onslow.

Here figured from the holotype.

EPINEPHELUS HOMOSINENSIS Whitley, 1944.

(Plate xxv, fig. 3.)

Epinephelus homosinensis Whitley, Austr. Zool., x, 1944, p. 267. Geraldton.

Here figured from the holotype.

EPINEPHELUS TAUVINA (Bonnaterre, 1788).

(Plate xxv, fig. 4.)

Perca tauvina Bonnaterre, Tabl. Encycl. Meth. Ichth., 1788, p. 131, *ex* Forskal, 1775, non-binomial. Djedda, Red Sea.

The "Slimy Cod", as this is called in Western Australia, alters considerably in shape and colour as it grows.

A specimen 2,000 mm. (6 ft. 8 ins.) long was caught on a shark line at Red Bluff, Western Australia, on September 7, 1945; it had the following characters.

Br., 7; D.xi, 15; A.iii, 8; P., 19. L. lat. *c.*76 to hypural joint. L.tr., about 16/1/50 to 10/1/14 on caudal peduncle. Head (655 mm.) equal to depth and $3\frac{1}{2}$ in standard length (1,690). Eye, 46 mm.; interorbital, 182; snout, 150; maxilla, 320; length of pectoral, 342; preorbital, 50; depth of c. ped., 211; length of ventral fin, 256.

Head mostly scaly behind level of eyes. Preopercular margin serrate, with large coarse serrae at angle. Upper two opercular spines well advanced from third. Maxillary round, reaching beyond eye, naked, with supplemental bone. Teeth cardiform, in broad bands on jaws, vomer and palate; outer ones not enlarged, no canines.

Nostrils large, circular, the anterior ones with raised posterior rim. Gill-rakers, 6/1/16 spiny knobs. Cleithrum scaly.

Body covered with large ciliated scales. Back scaly. Base of first dorsal (580 mm.) much longer than that of soft (335); sixth dorsal spine longest (110), shorter than rays. Ventrals not nearly reaching vent, less than half-way. Fin-membranes not pencilled. First dorsal origin behind head. Third anal spine longest. Pectoral and caudal fins broadly rounded, the latter with 15 rays. The stomach contained a goat's leg. Weight 350 lbs. Pupil dark blue; iris bronze, becoming greenish outside. General colour of head and body dark greenish-grey, little lighter ventrally and browner posteriorly. Soft fins with many dark bluish-grey spots, less than pupil, also a few on lower parts of head and body. No dark moustache-mark. Teeth whitish. Vent brown.

Family LUTJANIDAE.

CAESIO LUNARIS Cuv. and Val., 1830.

Caesio lunaris Cuvier and Valenciennes, Hist. Nat. Poiss., vi, September, 1830, p. 441, *ex* Ehrenberg MS. Red Sea and New Ireland. *Id.*, Fowler, Bull, U.S. Nat. Mus., 100, xi, 1931, p. 205.

One from the Monte Bello Islands, September 18, 1945. Austr. Mus. regd. no. IB.1566.

New record for Australia as well as Western Australia.

LUTJANUS VAIGIENSIS (Quoy and Gaimard, 1824).

Diacope vaigiensis Quoy and Gaimard, Voy. Uranie Physic., Zool., December, 1824, p. 307. Waigiou.

Lutjanus vaigiensis Fowler, Bull. U.S. Nat. Mus., 100, xi, 1931, p. 115.

A specimen, $9\frac{3}{4}$ inches long, was collected amongst the Monte Bello Islands, September 17, 1945. Austr. Mus. regd. no. IB.1558.

New record for Western Australia.

Family TRICHIURIDAE.

TRICHIURUS COXII Ogilby, 1887.

Trichiurus coxii Ogilby, Town and Country Journal, Oct. 15, 1887, p. 808, and fig. *Id.*, Ramsay and Ogilby, Proc. Linn. Soc. N.S. Wales, (2) ii, 1887, p. 562. Broken Bay, N.S. Wales. *Id.*, Whitley, Austr. Mus. Mag., iv, 1930, p. 97, fig. of head; and of authors.

Messrs. A. J. Fraser and L. Glauert (*in litt.*) have informed me that Mr. Nicholas Soulos obtained a haul of 300 lbs. of Hairtail at Bunbury on December 1, 1947, and details supplied indicate this species.

New record for Western Australia.

Family POMACENTRIDAE.

DISCHISTODUS PERSPICILLATUS (Cuv. and Val., 1830).

Pomacentrus perspicillatus Cuvier and Valenciennes, Hist. Nat. Poiss., v, July, 1830, p. 417. Loc. unknown. *Id.*, Kner, Reise Novara (Fische), 1865, p. 241. *Id.*, Fowler, Bull. U.S. Nat. Mus., 100, vii, 1928, p. 101 (refs. and synon.).

Pomacentrus trimaculatus Cuv. and Val., *loc. cit.*, p. 427. Batavia. Preocc. by *P. trimaculatus* Rüppell, Atlas Reise (Senckenb. Nat. Ges.), Fische, 1829, p. 39.

Dischistodus trimaculatus Bleeker, Nat. Verhand. Holl. Maatsch. Wetensch. (3) ii, 1877, p. 79; Atlas Ichth., ix, 1877, pl. 404, fig. 5.

Pomacentrus marginatus Bleeker, *loc. cit.*, p. 80, in synonymy. *Ex* Kuhl and Van Hasselt M.S. Preocc. by *P. marginatus* Rüppell, *loc. cit.*, 1829, p. 38.

Pomacentrus trimaculatus Macleay, Proc. Linn. Soc. N.S. Wales, vii, 1882, p. 363. *Id.*, Jordan and Seale, Bull. U.S. Fish. Bur., xxv, 1905 (1906), p. 280. *Id.*, Montalban, Phil. Bur. Sci. Monogr., xxiv, 1928, p. 64, pl. xii, fig. 2.

Pomacentrus frenatus De Vis, Proc. Linn. Soc. N.S. Wales, ix, 1885, p. 874. Cardwell, Queensland.

Pomacentrus dorsomaculatus Kendall and Goldsborough, Mem. Mus. Comp. Zool. Harvard, xxvi, 1911, p. 298. New name for *P. trimaculatus* Cuv. and Val., preocc.

Dischistodus frenatus Whitley, Mem. Qld. Mus., ix, 1929, pp. 222, 228 and 236, fig. 4 (not 3).

One specimen, $7\frac{1}{8}$ inches overall, collected amongst the Monte Bello Islands on September 18, 1945, constitutes a new record for Western Australia. It is dark chocolate in colour, with a large black spot at vent and black pectoral axil, but the dark blotches along the back are indistinct. *P. frenatus* De Vis appears to be a new synonym of this species, which was otherwise not listed from Australia.

GLYPHISODON PALMERI Cockerell, 1913.

Glyphisodon palmeri Cockerell, Mem. Qld. Mus., ii, 1913, p. 57; Ogilby, *ibid.*, p. 87, pl. xxii, fig. 2. Moreton Bay, Queensland.

One from the North-West Division, Western Australia. Austr. Mus. regd. no. IB.1574.

New record for Western Australia.

Pomacentrus obreptus, sp. nov.

D.xiii, 17; A.ii, 14; P.ii, 18. L. lat., 20 tubes. Sc., 25 to hyp. Tr., 4/1/11.

Head (34 mm.), 3·2, depth (57), 1·9 in standard length (110). Eye (8) less than snout (10) and interorbital (12). Maxillary, 7 mm.; length of ventral fin, 30; second anal spine (16) less than length of pectoral (18 mm.).

Head scaly above to before nostrils, only naked on anterior parts of preorbital and chin, where there are pores, and on mouth. Maxillary not quite reaching below eye. Teeth compressed, with truncate tips, uniserial; rami very slightly raised. Suborbital and both preopercular limbs serrate, not notched, other opercles entire. Suborbital and preopercular limbs scaly. Cheek-scales in about five rows. Upper opercular spine flat, not covered by scale. Interorbital broadly convex.

Body deep, covered with ctenoid scales with about seven basal radii and opaque field with obscured circuli. Some of the scales of the shoulder region accompanied by a basal auxilary scale; scales extend over most of fins.

Base of spinous dorsal fin longer than that of soft. Membrane incised and pencilled. Fins rather pointed, except lobes of anal and caudal, which are rounded. Ventrals reach vent.

Colour in alcohol, fairly uniform dark brown to blackish, edges of body scales lighter brown. No striking colour-markings though, from memory, I think the anterior ventral ray was violet in life. No dark blotch at vent. Pectoral axils dark but without definite dark blotch.

Described from the holotype, a specimen 110 mm. in standard length or 5½ inches overall.

Loc.—Monte Bello Islands, Western Australia; September 18, 1945, coll. G. P. Whitley aboard ketch *Isobel* under C.S.I.R. charter.

Holotype: Austr. Mus. regd. no. IB.1571. A smaller specimen (paratype) taken at the same time is no. IB.1572.

Superficially similar to *Pomacentrus jenkinsi* Jordan and Evermann, 1903, from Honolulu, with two Hawaiian specimens of which I have compared my examples. Western Australian fishes are larger, have comparatively smaller eyes end less rounded anterior profiles than the Hawaiian and also differ in having the scales dark brown with lighter edges (instead of the contrary); four rows of scales above l. lat. anteriorly, and no dark spot at pectoral origin.

From all other species the novelty is distinguished by the combination of characters embodied in the description.

Family Coridae.

Coris cyanea Macleay, 1883.

Coris cyanea Macleay, Proc. Linn. Soc. N.S. Wales, vii, 1883, p. 588. New Guinea. *Id.*, Whitley, Austr. Zool., viii, 1937, p. 227, pl. xiii, fig. 3.

Abrolhos Islands, August, 1947.

New record for Western Australia.

Lat., 52 + 12 to hypural. Tr., 9/1/23.

Sent to the Fisheries Dept., Perth, as a "Black Snapper".

Family Callionymidae.

Repomucenus calcaratus (Macleay, 1881).

Callionymus calcaratus Macleay, Proc. Linn. Soc. N.S. Wales, v, 1881, p. 628. Port Jackson, N.S. Wales. *Id.*, McCulloch, Rec. Austr. Mus., xiv, 1923, p. 10, pl. iii, fig. 2, and Biol. Res. Endeav., v, 1926, p. 204.

Repomucenus sp. Whitley, Austr. Zool., xi, 1945, p. 42.

The Australian Museum has examples of this species from Fremantle, the Houtmans Abrolhos, Shark's Bay, between Cape Jaubert and Wallal, and even as far as the Northern Territory (Lat. 12° 12′ S. × Long. 130° 36′ E.). I had thought that the Shark's Bay ones, which I collected in 1939, and the Northern Territory example, from Mr. M. Ward, might represent a new species, having D.iv 8, A. 7; no light ocelli on back, few rugae on occiput, and with slightly different proportions from the Port Jackson type. But Houtmans Abrolhos examples are inseparable from *calcaratus*; they have 9 dorsal and anal rays and a dusky wash along lower caudal membranes, and smooth occiput. The other specimens have up to 10 dorsal rays, lower caudal membranes spotted, three to four preopercular hooks, and black marks on first dorsal variable. Thus only one species appears to be represented, with perhaps mutants at Shark's Bay and in the Northern Territory. The species has not hitherto been recorded from the latter State.

Family TETRAODONTIDAE.

OVOIDES IMPLUTUS (Jenyns, 1842).

Tetrodon implutus Jenyns, Zool. Voy. Beagle, Fish. 1842, p. 152. Keeling Is.

One from the Monte Bello Islands, collected by me, September 18, 1945. Austr. Mus. regd. no. IB.1565.

New record for Western Australia.

EXPLANATION OF PLATES.

Plate xxiv.

Heads of Hammerhead Sharks, *Sphyrna lewini* (Griffith), drawn to scale.

Fig. 1.—Female with hammer 1 foot across. from off Bald Head, Western Australia (Specimen no. 2 in text).

Fig. 2.—Female, hammer 6·4 ins. across, from Second Beach, Esperance, W.A. Dorsal surface (stippled) on left of diagram (Specimen 5 in text).

Fig. 2*a*.—Ventral surface shown to right of stippled area.

Fig. 2*b*.—Skull of same in situ, from dorsal surface, showing minute rostral foramen.

Fig. 3.—Female, hammer 5·6 ins. across, from Connor's Creek, Queensland (Specimen 1 in text).

G. P. Whitley del.

Plate xxv.

Fig. 1.—Freshwater Cobbler, *Tandanus bostocki* Whitley. Type from Serpentine.

Fig. 2.—Rankin's Rock Cod, *Epinephelus rankini* Whitley. Type from Onslow.

Fig. 3.—Chinaman Cod, *Epinephelus homosinensis* Whitley. Type from Geraldton.

Fig. 4.—Slimy Cod, *Epinephelus tauvina* (Bonnaterre). A large example, 6 ft. 8 ins. long, from Red Bluff.

G. P. Whitley del.

TWO NEW SPECIES OF AUSTRALIAN DRYOPOIDEA (COLEOPTERA).

By E. H. ZECK.

(Text-figures 1–4.)

Since the last paper on "Four New Species of Australian Dryopidae", by Carter and Zeck, which was published in the AUSTRALIAN ZOOLOGIST, vol. ix, pt. ii, 1938, various changes have taken place in the classification of this group of beetles.[1]

The family Dryopidae, as then understood, was included in the superfamily DIVERSICORNIA by Imms, and in the superfamily ELATEROIDEA by Tillyard. The Elminae, then a subfamily of the Dryopidae, have now the status of family rank and are included in the superfamily DRYOPOIDEA.

The two new species, now described, belong to the family Elmidae.

Genus AUSTROLIMNIUS Carter and Zeck, 1929.[2]

AUSTROLIMNIUS ISDELLENSIS, sp. nov.

(Figs. 1 and 2.)

Widely obovate, subnitid above, head and prothorax black, the latter with apex reddish; elytra black with about basal fourth dark ochreous, underside black. Antennae, tibiae and tarsi reddish.

Prothorax rounded, and only slightly produced at apex, front angles obtuse, widest behind middle, sides rounded, base wider than apex, lateral carinae slightly bisinuate, converging somewhat towards apex, median impression (sulcus) shallow, widest at base and narrowing at about basal fourth and again at apex; surface minutely and shallowly punctate, covered with scattered, fine, recumbent hairs.

Elytra widest behind middle, carinae distinctly raised, inner pairs serrulate, margin strongly serrate. Seriate punctures shallow. Intervals minutely punctate. Surface covered with short recumbent hairs.

Prosternal process bisinuate at sides, sub-acute at apex.

Dimensions: $0{\cdot}9 \times 0{\cdot}5$ mm.

Habitat: North-western Australia; limestone tributary of left bank of the Isdell River (10 miles from mouth of river in Walcott Inlet). September 1, 1943. Dr. Consett Davis. One specimen only on roots of water plant.

Seen from above, this species, in outline, comes near to *Austrolimnius suffusus* C. and Z., and *A. victoriensis* C. and Z., but its form is much wider and its legs are unusually stout. It is the smallest Australian species of the genus.

Holotype in Coll. Zeck.

Genus KINGOLUS Carter and Zeck, 1929.[3]

KINGOLUS DAVISI, sp. nov.

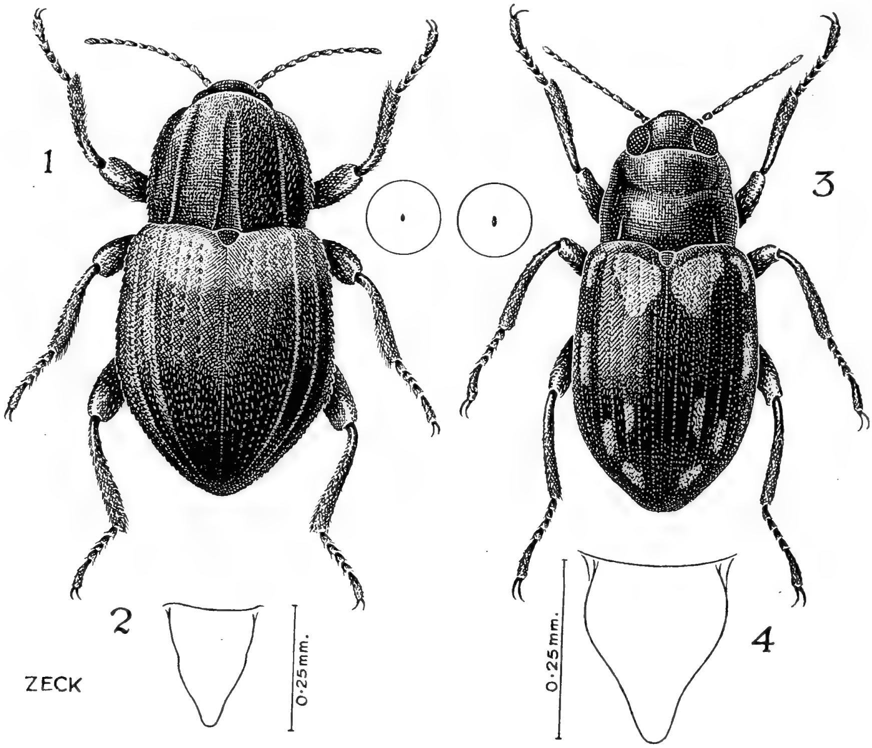
(Figs. 3 and 4.)

Rather elongate, narrowly obovate, subnitid violet-bronze above; antennae and tarsi brownish, femora and tibiae darker. Each elytron bears six dark-ochreous markings, three narrow lateral, one in third interval at about apical third, one apical and a large basal one adjoining suture.

Head black, with metallic bronze sheen, finely punctate, with fine white hairs.

Prothorax sub-bilobed, anterior part not entirely divided from the posterior by shallow transverse depressions, meeting shallowly at the middle, apex sub-truncate, widest behind middle, sides lightly and evenly rounded, narrower anteriorly than posteriorly, lateral border very narrow, finely granulate with scattered, fine whitish hairs and with small, widely spaced punctures, margins entire. Scutellum sub-triangular, with rounded sides and apex.

Elytra wider than prothorax at base, widest at about apical third, striate-punctate, elytral striae shallow and punctures small, fine scattered punctures in intervals, the whole bearing distinct recumbent whitish hairs.



Figs. 1-4.—1. *Austrolimnius isdellensis* Zeck. Type. 2. *Austrolimnius isdellensis* Zeck. Sternal process. 3. *Kingolus davisi* Zeck. Type. 4. *Kingolus davisi* Zeck. Sternal process.

Underside black, minutely punctate, and covered with scattered whitish hairs; prosternal process densely so, prosternum smooth laterally, minutely tomentose. Prosternal process sub-triangular, sinuate at sides, narrowing to a sub-acute apex.

Dimensions: 1·4 × 0·6 mm.

Habitat: North Queensland, Wild River, Ravenshoe. April, 1943. Consett Davis. Three examples and a fragment are before me. Seen from above, this species, in outline, comes closest to *Kingolus metallicus* King and *K. tyrrhenus* C. and Z. This species is named in honour of its discoverer, the late Dr. Consett Davis.

It is the smallest species of the genus and is readily distinguished from other members by the six ochraceous markings on each elytron.

Holotype in Coll. Zeck.

References.

(1) HINTON, H. E. (1939).—"An enquiry into the natural classification of the Dryopoidea, based partly on a study of the internal anatomy", *Trans. R. ent. Soc.*, 89, pp. 33-184.

(2) CARTER, H. J., and ZECK, E. H. (1929).—"A Monograph of the Australian Dryopidae (Order Coleoptera)", *Aust. Zool.*, vi, pt. 1, p. 61.

(3) CARTER, H. J., and ZECK, E. H.—*L.c.*, p. 53.

A NEW AQUARIUM FISH FROM NORTH QUEENSLAND.

By G. P. WHITLEY, F.R.Z.S.
(Contribution from The Australian Museum, Sydney.)

In November, 1947, an attractive aquarium fish was introduced to the notice of Sydney fish-fanciers from the Coen district, North Queensland. The novelty reminded them somewhat of the Cichlids, being prettily patterned and similarly shaped, actively moving all the time and chasing one another as if to make a grab as the Cichlids do. But the Cichlidae are mostly native to South America and Africa and do not occur in Australian rivers, and it was soon evident that ours was a Terapontid fish.

Thanks to Mr. W. C. Roberts, of Austral Aquariums, and Mr. J. C. Woore (whose cousin had originally collected the fishes in Queensland), I saw the living fishes and received a specimen for the Australian Museum. On investigation this species proved to be a new one and is named below.

Family TERAPONTIDAE.

Genus LEIOPOTHERAPON Fowler, 1931.

Leiopotherapon suavis, sp. nov.

Br., 6; D.xii, 14; A.iii, 11; P., 16; V.i, 5; C., 15 branched rays. L. lat., 53. Sc., *c.*50. Tr., 10/1/20.

Head (22 mm.) 2·8, depth (25) 2·4 in standard length (62). Eye equal to maxillary (7), greater than interorbital which equals snout (5), the latter 2 in postorbital (10).

Head rather pointed, profile obliquely sloping, not concave before eyes. Preopercle serrated, other opercles and the preorbital entire. Lower opercular spine barely reaching opercular lobe. Top, bottom and front of head before eyes naked, rest scaly. Cheek-scales in seven rows below eyes. Posterior nostril large and circular, well separated from the inconspicuous anterior nostril. Some pores around preorbital and mucous canals each side of the broadly convex interorbital. Lips normal; jaws subequal. Premaxillary pedicels more than half eye. Gape oblique. Angle of maxillary not covered by lip and not reaching eye. A single row of conic teeth around each jaw with interior bands of villiform ones crossing symphyses. Vomer and palatines toothless. Gill-openings wide, gill-membranes united across narrow isthmus. Body deep, compressed, covered with sculptured ctenoid scales. Supracleithrum covered by scales, ending with few denticles. Lateral line complete with simple tubes. Dorsal and to a less extent anal with basal scaly sheaths. Dorsal spines heteracanth, last ray divided to base. Sixth to eighth dorsal spines longest but shorter than the rays, penultimate spine longer than last. Soft dorsal and anal convex. Second anal spine longest; last anal ray divided to base. Upper pectoral rays longest. Ventrals pointed, reaching vent. Caudal truncate.

Colours of live aquarium specimens: Ground colour of head and body yellowish-cream densely criss-crossed by a pattern of brownish-grey. On the head the dark marks form oblique bars on the cheeks and reticulation elsewhere. On the body there are about five to eight irregular cross-bars and about seven to ten longitudinal bands, but these are broken up in places by splashes of the lighter ground-colour. Most of the caudal peduncle is dark, with two to four patches of light ground-colour. Top of head plain, pale olivaceous with pinkish tinge. A dark spot between gills and pectoral axil. Pupil of eye dark blue, iris coppery.

Fins plain, pale or infuscated but without definite markings. Ventrals dark. Sometimes a pinkish or greenish tinge apparent and the general hues change slightly in the living fish. (The pectorals, caudal, soft dorsal and anal are mainly used in swimming. Sometimes they shelter under water weed leaves.)

Colour in alcohol: Ground-colour creamy, densely overlaid by irregular subhorizontal and subvertical dark grey bars and bands giving roughly a draughtsboard-like pattern. The cream ground is most evident on lower flanks and just before root of tail. Top of head olivaceous. Breast very light grey, unmarked. First dorsal olivaceous to greyish with no large dark blotch; other fins grey to yellowish, plain. Cheeks and opercles crossed by bars of dark grey or brown and creamy. Most fin-membranes dark.

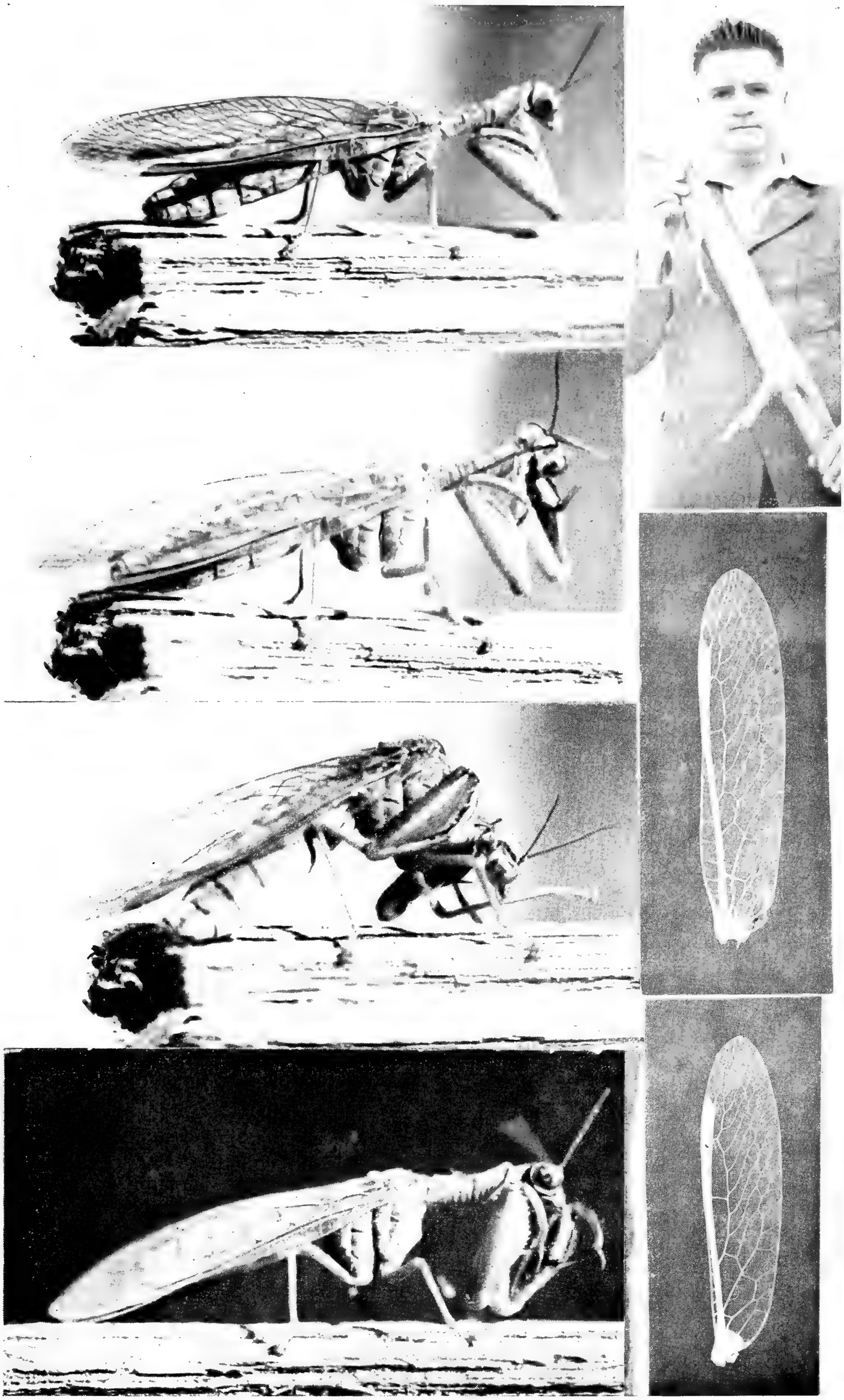
Described from the holotype, a specimen 62 mm. in standard length or 3 inches overall. Austr. Mus. regd. no. IB.1982.

Loc.—Coen district, North Queensland.

This new species is quite distinct from its congeners, being distinguished by the form and formulae of the fins, the coloration and other characters as described above. Probably nearest *Terapon habbemai* Weber, 1910, from southern rivers of Dutch New Guinea, but with lower first and higher second dorsal fins, cross-bars well marked, more rays, larger eye, etc. *T. adamsoni* Trewavas, 1940, from Lake Kutubu, New Guinea, is plain-coloured.

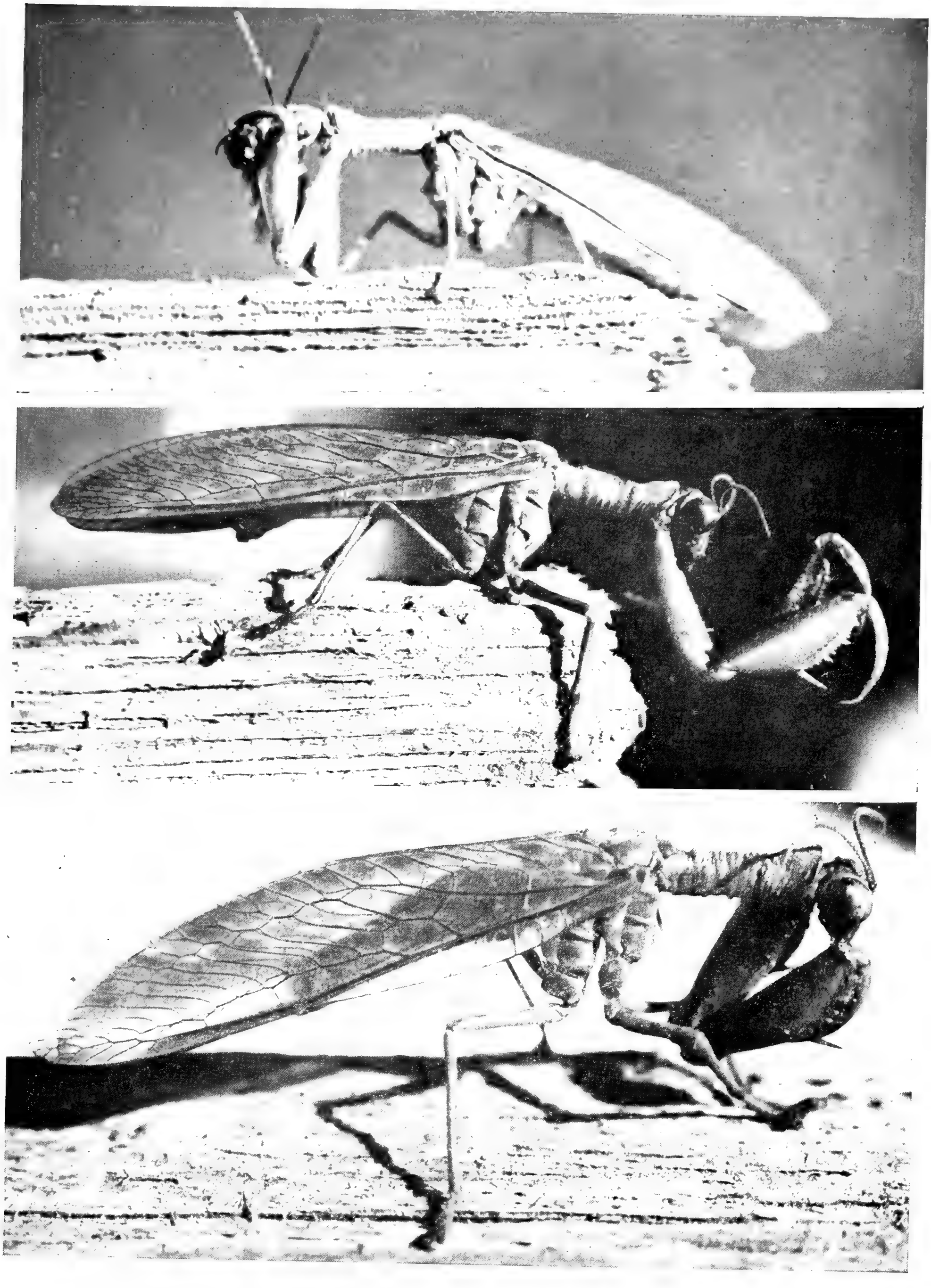
"NATURE SPEAKS" OVER 2GB.

A new kind of "Brains Trust" session, of interest to nature-lovers and zoologists alike, has been inaugurated by the Macquarie Broadcasting Network under the sponsorship of Mr. E. J. L. Hallstrom, F.R.Z.S. Station 2GB, Sydney, now broadcasts "Nature Speaks" on Saturday evenings at 7.45 o'clock, E.S. time. A panel of experts, all of whom are members of the Royal Zoological Society, answers (and welcomes) listeners' questions about any form of animal life, in fact, "anything that walks, burrows, crawls, flies or swims". The idea of the new Nature Quiz is not to "stump" the experts so much as to elicit accurate and attractively presented information on all faunal and zoological matters, particularly with regard to the protection of our native animals, whose conservation will be at all times favoured. Under the genial direction of Mr. John Dease, "Nature Speaks" assures listeners of an entertaining and instructive half-hour. Members of the panel are Messrs. H. Brown, J. R. Kinghorn, R. Patten, E. Troughton and G. P. Whitley.



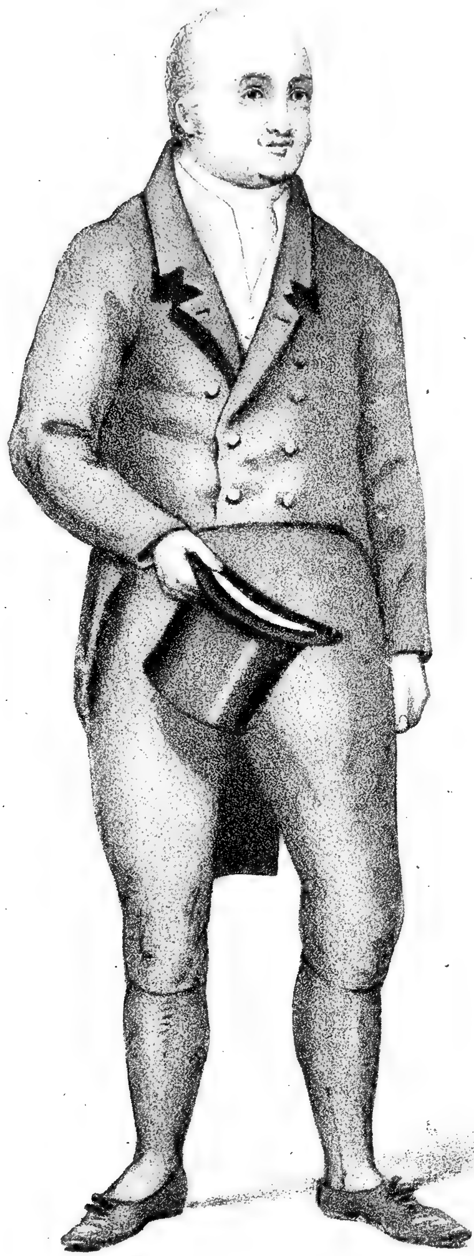
An Australian Mantispid.

Photos.—Crosbie Morrison and
V. Hans Mincham.

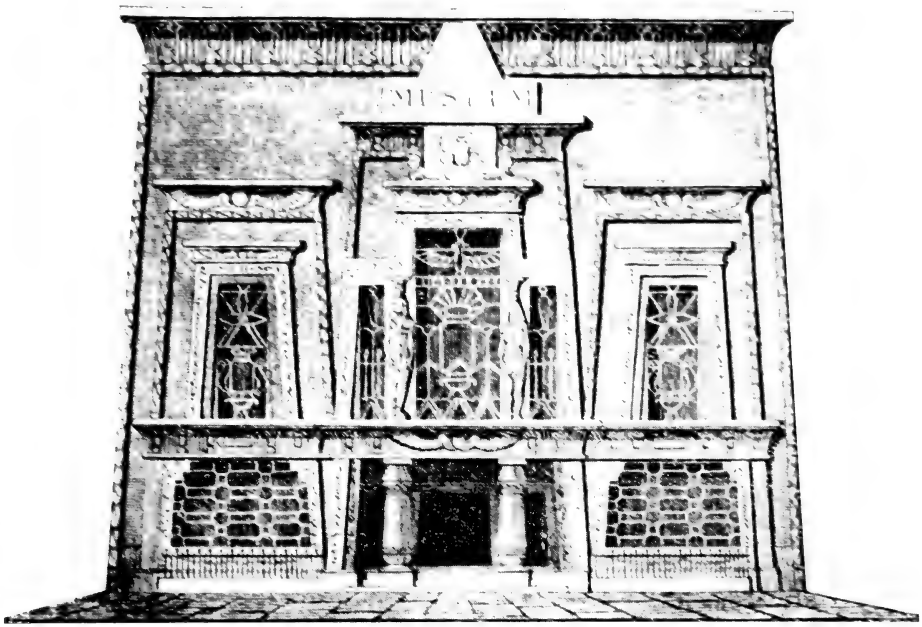


An Australian Mantispid.

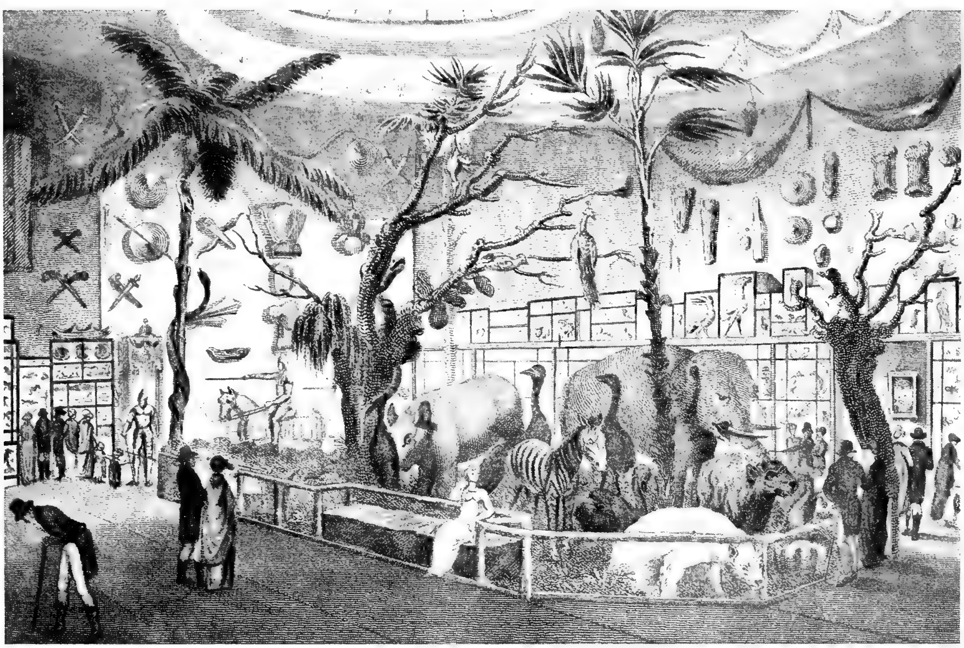
Photos.—Crosbie Morrison.



William Bullock.
After Rowley.

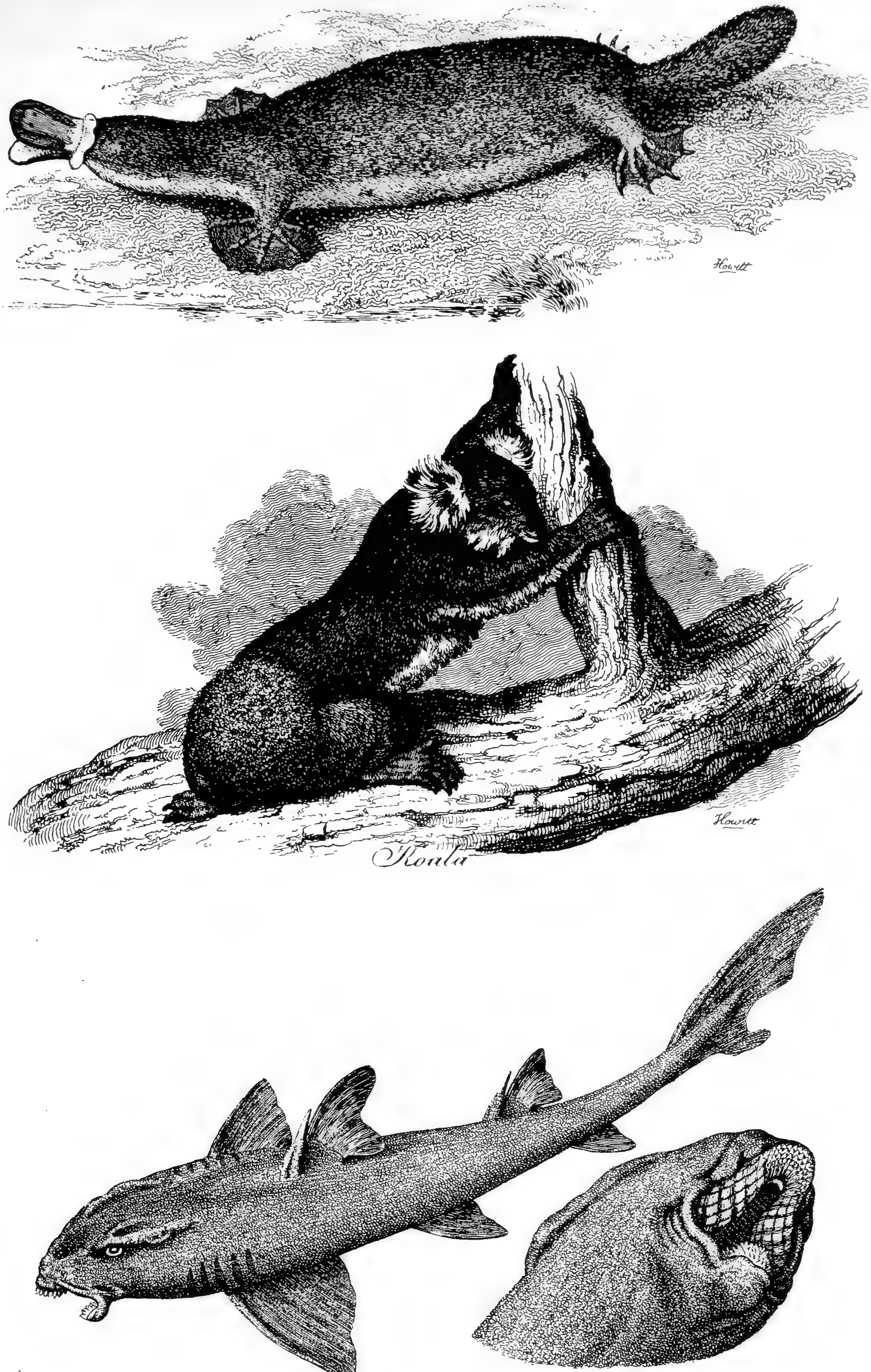


Bullock's Museum (later the Egyptian Hall), Piccadilly.



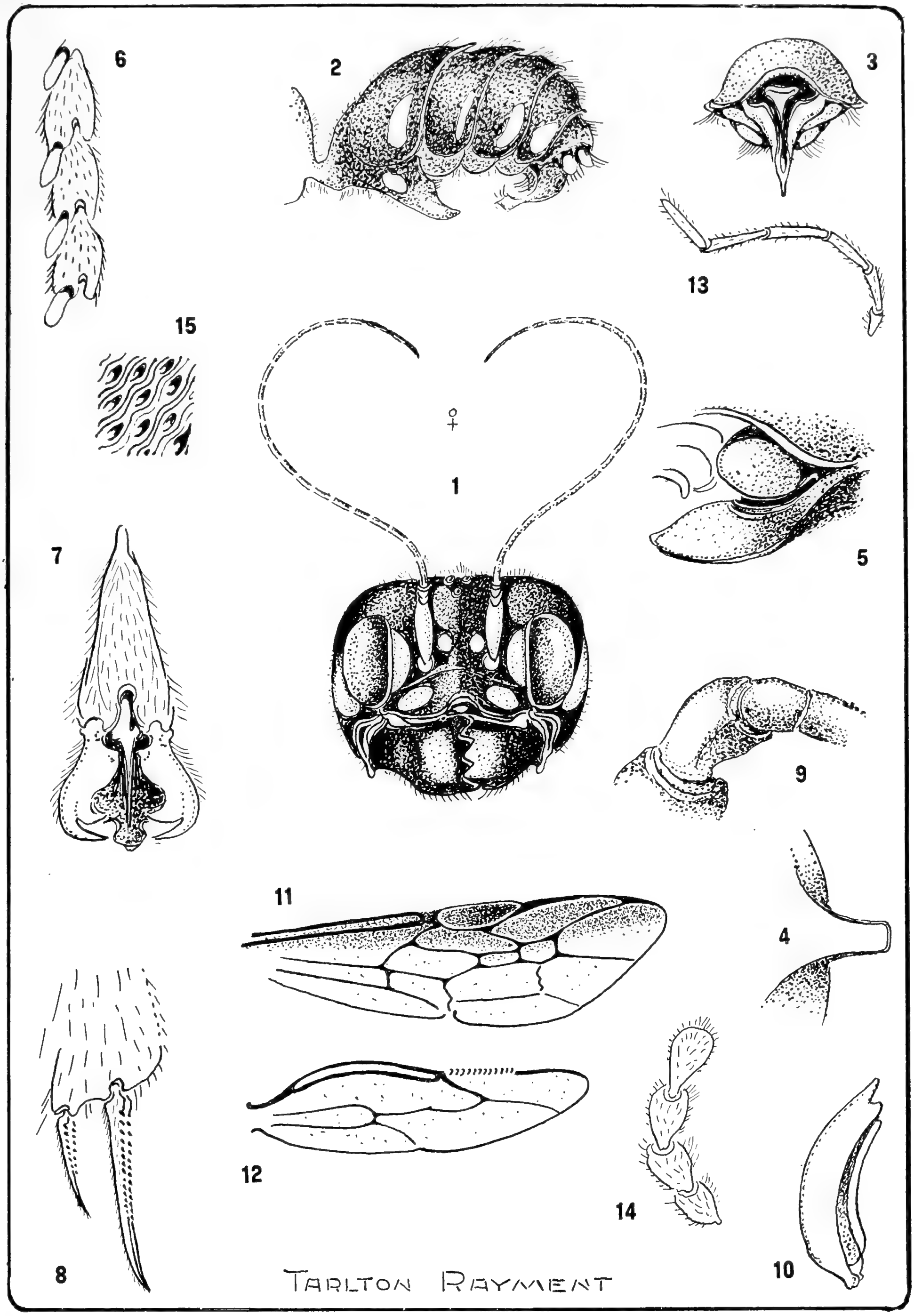
Interior of Bullock's Museum.

After Bullock.

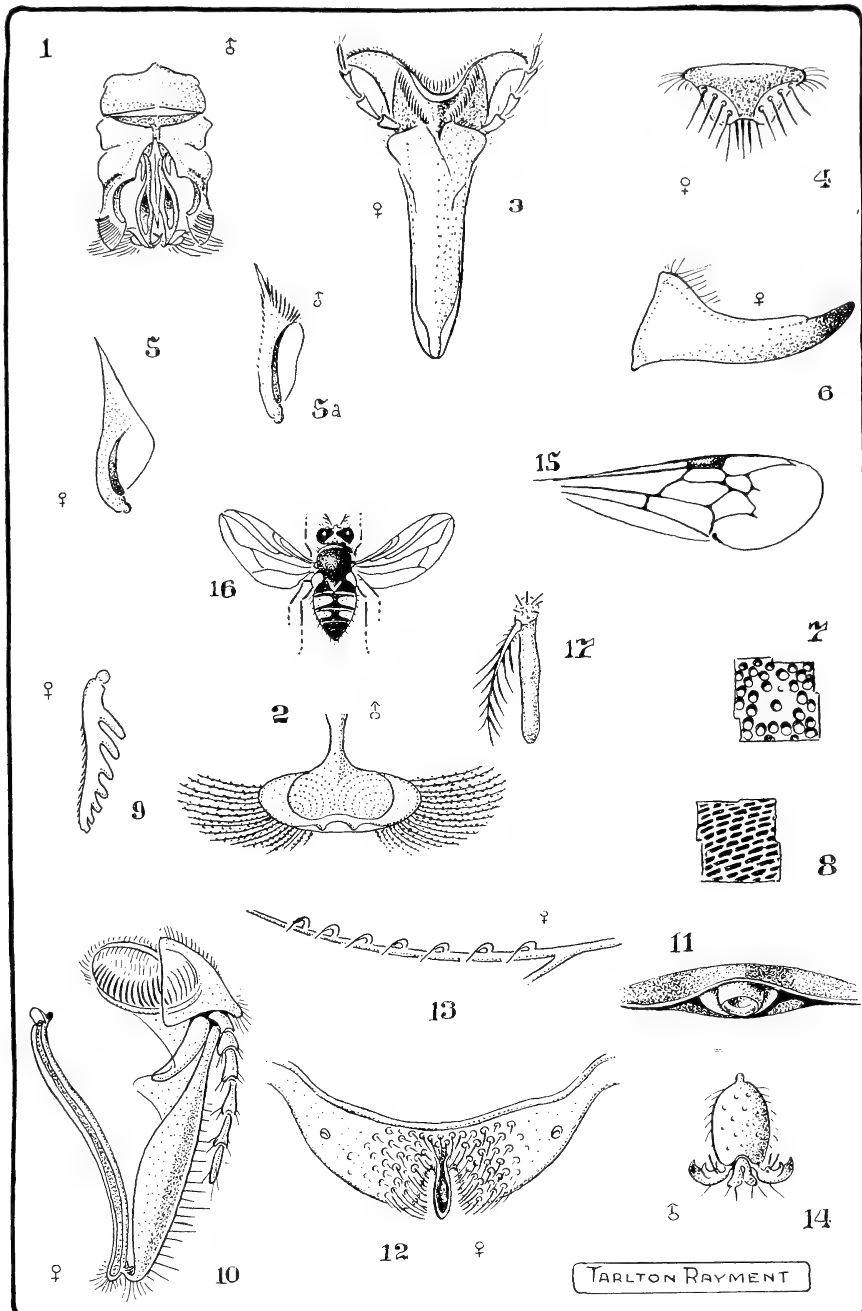


Australian Animals in Bullock's Museum (Platypus, Koala, and Port Jackson Shark).

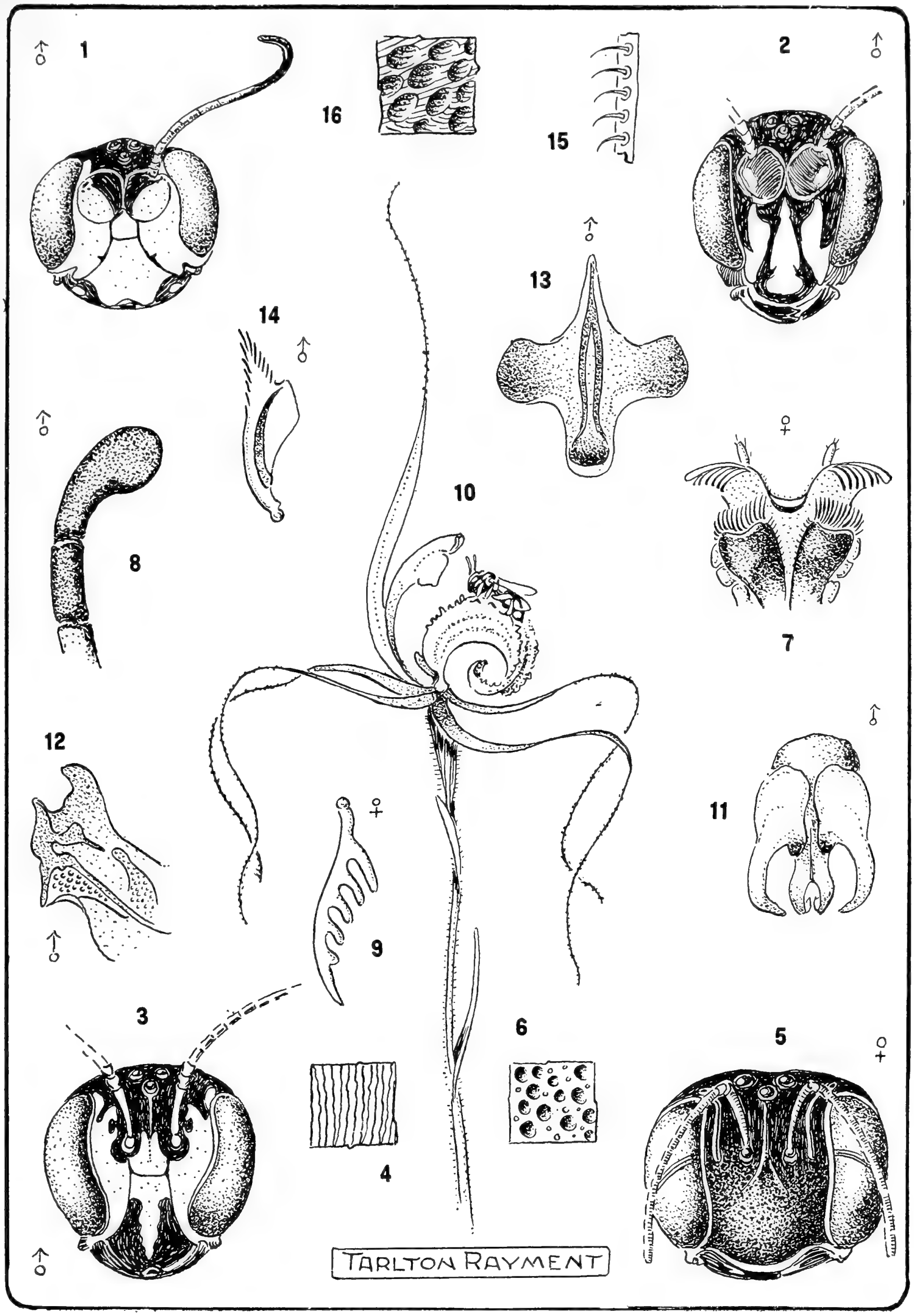
After Bullock.



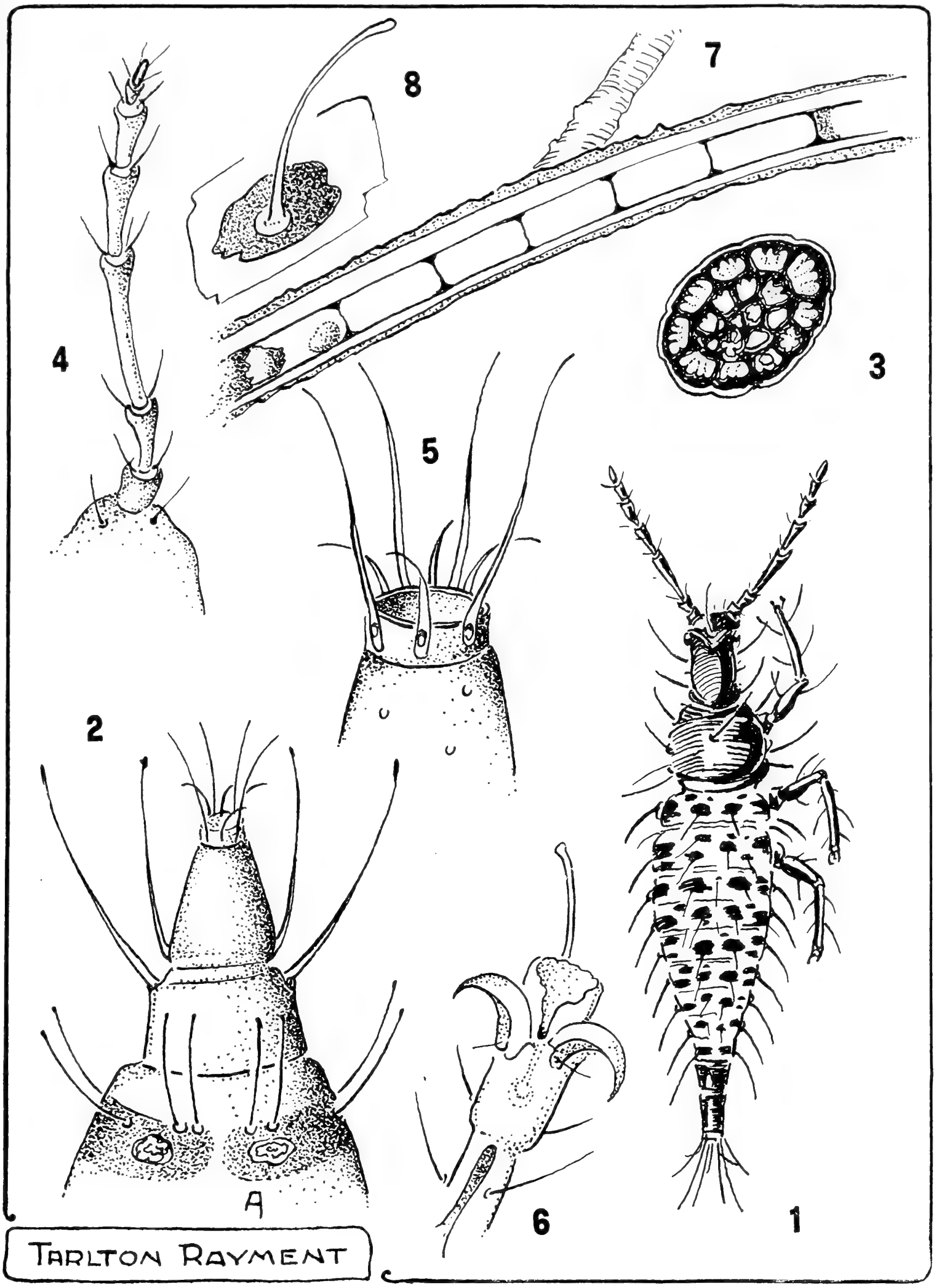
Taeniogonalos heterodoxus Rayment.



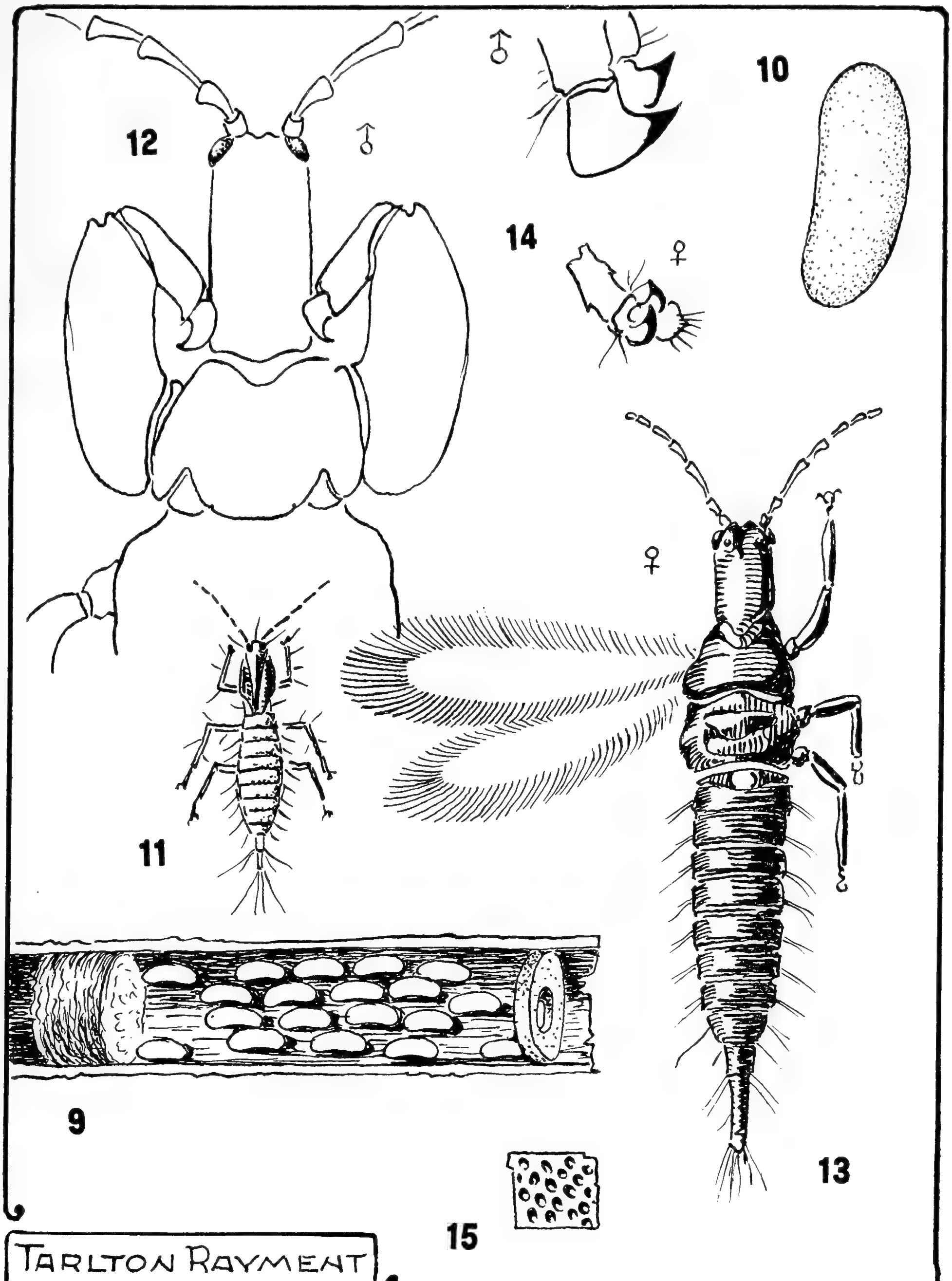
Euryglossimorpha nigra (Smith).



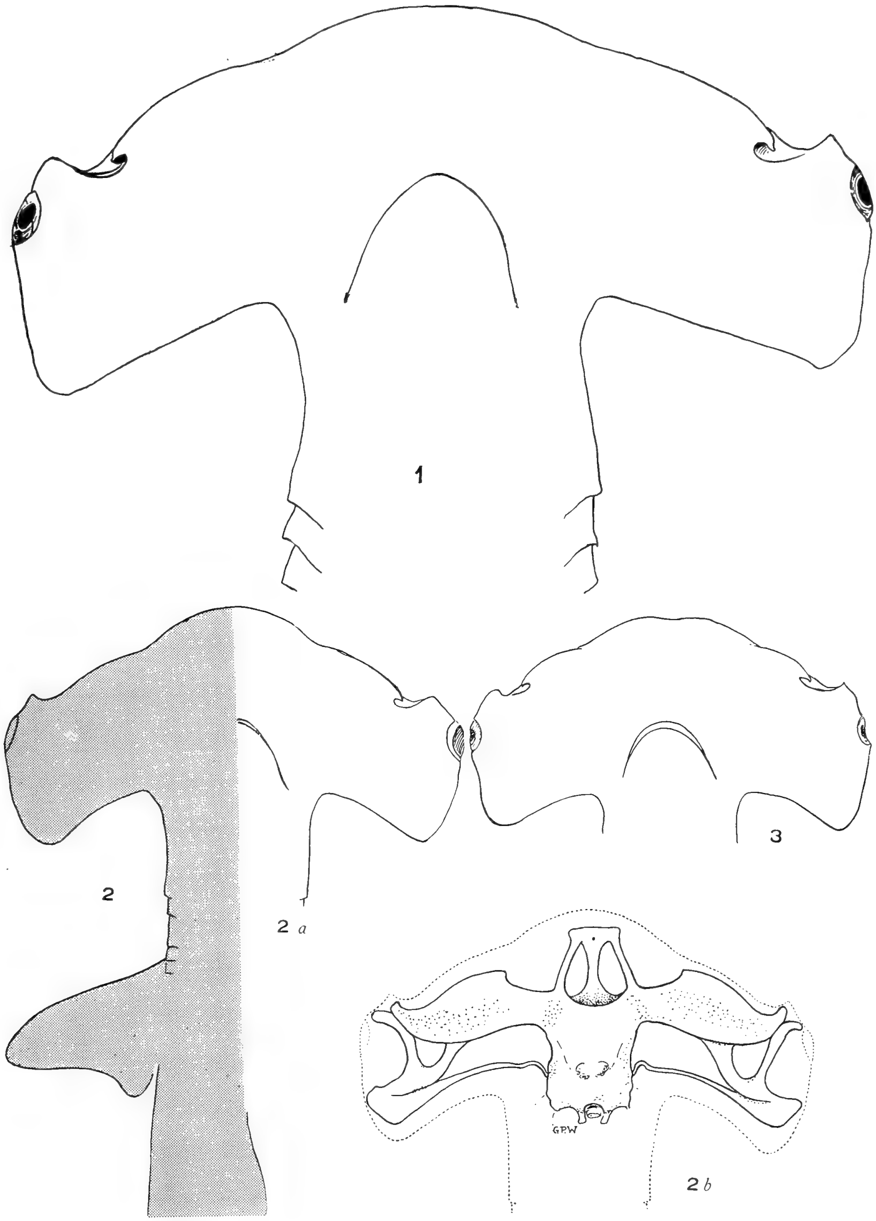
A Bee and an Orchid.



New Australian Thrips.

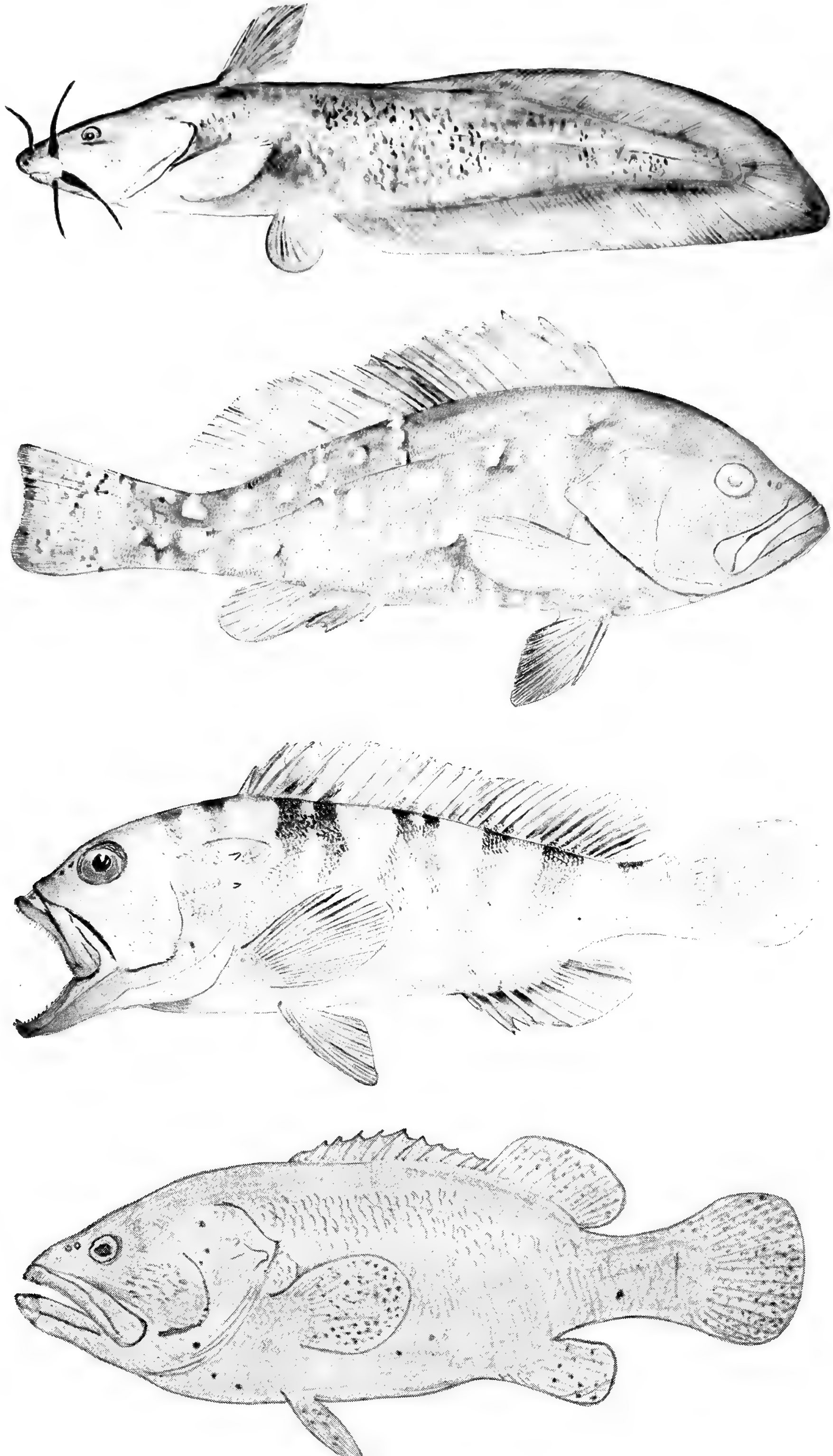


New Australian Thrips.



Hammerhead Sharks.

G. P. Whitley del.



Western Australian Fishes.

G. P. Whitley del.

Royal Zoological Society of New South Wales

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THE AUSTRALIAN ZOOLOGIST

Vol. XI. Part 4.

DEEP-SEA SHELLS FROM NEW SOUTH WALES.

By Allan R. Mayblom.

(Plate xxvi.)

During recent years I have done considerable collecting from the trawlers operating on the Continental Shelf on the New South Wales coast, with the result that many puzzling variations have been seen in some species obtained. In many cases this seems due to varying depth from which specimens are obtained. However, up to date it has been almost impossible to ascertain with any certainty the exact depth from which any individual specimen may come. This is due to the fact that the usual practice in trawling is to lower the net in, say, 70-80 fathoms, and to bring it up in 50-60 fathoms. The results of this are that all the shells living between these depths are brought in together with no possible check on the exact depth from which any one shell may have come. The majority of shells come from between these depths. However, sometimes the trawl is lowered to 110 fathoms and at times it only reaches 40 fathoms. It is during these latter trawls that the material obtained may help to give us an overall picture of the causes of changes in the shape, size and colour of many species. It seems certain that scientific trawling in exact depths with the aid of specially constructed dredges is the only satisfactory way in which to classify shells according to their variation.

Illustrated here are three possible examples of these changes. The first is in regard to the change in colour which is evident in the well-known *Livonia mamilla* Sowerby, 1844. This shell ranges in depth from 50-80 fathoms and deeper. However, from 70 fathoms they tend towards paleness in the aperture coloration. Then around 70-80 fathoms the occasional shell characterised by the pure porcelain white aperture is obtained. The latter is so well defined that I have given it the name of *leucostoma*. However, I am still rather doubtful as to whether this change is caused by depth, as the *leucostoma* does live together with the ordinary *mamilla* and also the change in colour is not gradual, but there is a sharp contrast between the two.

On the other hand, the rarer *Cymbiolena magnifica* Shaw and Nodder, 1808 (plate xxvi., fig. 2), occurs in comparatively shallow water, around 20 fathoms. Here the shell is quite ovate, broad, and the spire very short. However, an occasional shell is found in anything down to 60 fathoms, where it is larger, narrower and with a much longer spire. To this latter form I have given the subspecific name of *altispira*.

The now common, once rare, *Umbilia hesitata* Iredale, 1916, formerly *umbilicata*, was first found washed up on beaches in Bass Straits (coming from shallowish water). These shells were rather small, solid and well coloured. Years later it was found to be commonly occurring in intermediate depths, where it was larger, and on the whole, paler and thinner, while its form was very similar to the smaller shallow water type. As the depth increases, the shells still tend to become larger and paler until around 80-100 fathoms the pure white *howelli* Iredale, 1931, is sometimes found.

Another shell which appears to be greatly affected by depth is the common *Xenogalea stadialis* Hedley, 1914, which is found on the continental shelf of S.E. Australia in 40-100 fathoms. In shallow water the shell is small, usually averaging 65mm. However, the size increases rapidly with depth until in 80 fathoms shells up to 95mm. are commonly trawled.

With *Xenogalea thomsoni* Brazier, 1875, similarly sized specimens are also found. However, in this case the change is more marked because the smaller shells are more solid, the shouldering heavier and more pronounced, while the

nodules are very much in evidence. The larger shells are thinner, while at times the nodules are almost lost, especially on the lower whorl.

Berylsma waitei Hedley, 1903, is perhaps the best example of the change which takes place as the depth increases.

Berylsma waitei is found in 60-80 fathoms, and it is charactertised by a long spire and a very long canal, which give it a slender appearance. In about 25 fathoms the rare shorter spired relation of *waitei* is found. Here it is known as *Berylsma levifida* Iredale, 1924, while just below low water mark *Berylsma grandis* Gray, 1839, is found, having the general appearance of *waitei,* except the spire is shorter, shell fairly broad and the canal very short. Thus these three forms represent the change taking place in a shell in different depths.

Propefusus compositis is related to the shallow water form of *pyrulatus* Reeve, 1847. It is only very rarely found, due to its rather small size and probable rocky environment. Following on the lines of *Berylsma waitei,* it is thin and elongate and the very long and thin canal is quite characteristic.

A form of the well-known South Australian shell *Ericusa papillosa* Swainson, 1822, is found in southern New South Wales and Victorian waters, where it is known as *kenyoniana* Brazier, 1898. The latter form is quite variable in size, is more elongate than *papillosa,* and the exterior of the shell is marked with longitudinal ribs, which are especially prominent on smaller shells. While at first *kenyoniana* and *papillosa* were thought to be distinct, I have received from the trawlers many smooth specimens, some of which are not separate from the typical South Australian *papillosa* type. This suggests that *kenyoniana* is merely the deeper water form of *papillosa,* and this agrees with Verco's experience in the deep water of the Great Australian Bight. There he secured a small ribbed shell very like *kenyoniana.*

A small narrow, smooth form of *papillosa* has been secured in the northern sea of New South Wales, and has been named *Ericusa sericata* Thornley, 1951.

One of the most interesting finds is quite a new record for Australia. Some time ago a shell looking like half *Tonna* and half *Cassis* was brought in. It was something quite new, and while it was being considered and checked, I received a Japanese shell from America which was inseparable from the shell obtained here. The name of the shell received was *Eudolium pyriforme* Sowerby. Since then I have received a number from the trawlers, and the only possible difference between them and the Japanese type is the size, our shells apparently growing much bigger.

This shell affords an excellent illustration as to the similarity between some of our shells and those found in Japanese and Chinese waters. This is a remarkable fact, because in tropical waters separating these two geographical areas there occurs a completely different form of shell life, for the most part quite unlike anything found here or in Japan. Another classic example is the well-known *Tolema sertata* Hedley, 1903, which was at first recorded as *lischkeana* Dunker, 1852.

Family VOLUTIDAE.

Cymbiolena magnifica altispira, subsp. nov.

(Plate xxvi., fig. 1)

Shell large ovate and rather opaque; spire one-fourth overall length of shell and consisting of three whorls; apex comparatively small and rounded; nucleus containing three regularly round whorls; aperture large, narrowly ovate; columella marked with four large distinct orange coloured pleats.

The external colour is a brownish interlaced with white background overlaid with three bands of irregular chestnut and black markings. The aperture is a pale peach colour, and in live shells there is brownish band round the inner edge of the outer lip.

This shell differs only in shape, the outstanding point being the height of the spire, which is often twice as long in a specimen of *altispira* as in a similar sized specimen of the species. The shell is narrower, with the spire more conical and the aperture quite slender in comparison. A true *magnifica* is similar in appearance to a *Melo*, the aperture being extremely large and outer lip rounded, while the spire is short and very ventricose. In the case of *V. magnifica* the posterior canal ends quite close to the suture, while in *altispira* the canal ends two or three times further away from the suture.

Hab.: Usually occurs in deep water. They have been trapped alive as deep as 60 fathoms, and as a general rule the deeper they are the longer and more slender the shell.

Loc.: Port Stephens to Botany Bay.

COMPARISON OF MEASUREMENTS.

	altispira	*magnifica*
Total length	$9\frac{3}{8}''$	$9''$
Length of aperture	$7\frac{1}{8}''$	$7\frac{7}{8}''$
Length of spire	$2\frac{1}{4}''$	$1\frac{1}{8}''$
Width of aperture	$3\frac{1}{8}''$	$3\frac{3}{8}''$
Width of shell	$5\frac{1}{4}''$	$5\frac{1}{4}''$
Width of shoulder	$4\frac{3}{8}''$	$4\frac{5}{8}''$

Livonia mamilla leucostoma, subsp. nov.

(Plate xxvi., fig. 3)

Length: 200 — 250 mm.

Breadth: 130 mm.

Shell ovate, spire one-fifth of length, nucleus consists of one large mamilliform whorl with the apex very eccentric and lower down on one side; surface is wrinkled and of white to dirty white in colour. There are two and one-half post nuclear whorls; suture distinct and irregularly undulated. Lip thin and strongly recurved, extended slightly outwards and advancing upwards three-quarters of the height of the penultimate whorl. Anterior canal short, broad and open. Columella shallow, showing three distinct plaits, the upper one less pronounced.

Colour, tan, with a darker brown band below the suture; to a dirty white in some shells. Shell longitudinally irregularly marked with a broken design of brownish triangular streaks. Aperture is of a pure white porcelain colour. Base of last whorl is darker, showing distinctly a sinuation.

In shape and structure this shell agrees with the species, the colour of the aperture, which is brown in the species, and nucleus being the only distinction.

It is believed that this shell does not grow quite as large as the species and is generally thinner, the largest shell known to the author being $11\frac{1}{2}$ inches against 13 inches in the species.

Distribution: Generally below 80 fathoms around Gabo Is. in southern New South Wales seas.

Specimens have been reported as being very thin and almost pure white and coming from greater depths, but none have yet been brought to land.

Family FUSINIDAE.

Propefusus compositis, sp. nov.

(Plate xxvi., fig. 4)

Length: 70 — 100 mm.

Shell fusiform; spire long, pointed, almost half length of shell, rounded with rather a deep suture and consisting of seven whorls; nucleus white and containing

two whorls which end in a sharp point; aperture ovate; canal long, narrow slightly curved and open.

The penultimate whorl has six prominent encircling ridges with a smaller one suturally and an evanesent one anteriorly; the interstices rather wide and longitudinally ridged with about 15 elevated ribs which may become less marked and up to twenty on the last whorl. In some the longitudinal ridges are even more prominent and fewer in number. Inside the aperture the encircling ridges leave corresponding hollows through the rather thin outer wall, giving it a corrugated appearance.

The shell is coloured dirty white and covered with a tough thin brown epidermis. The longitudinal ridges are marked with a rusty line which shows clearly through the epidermis and giving it a brindled appearance.

Hab.: These shells would be more inclined to live in a rocky rather than a sandy environment, as they are only very occasionally caught. They are believed to live in 50-80 fathoms.

Loc.: Gabo Is. of southern New South Wales and extending into Victorian waters.

EXPLANATION OF PLATE xxvi.

Fig. 1: *Cymbiolena magnifica altispira* Mayblom.

Fig. 2: *Cymbiolena magnifica magnifica* Shaw & Nodder.

Fig. 3. *Livonia mamilla leucostoma* Mayblom.

Fig. 4: *Propefusus compositis* Mayblom.

Photo.—G. McGrath.

★

BIOLOGY OF THE REED-BEES.

With Descriptions of Three New Species and Two Allotypes of Exoneura.

By Tarlton Rayment, F.R.Z.S.

(Plate xxvii.-xxxii., text-figures 1-2)

Introduction.

The author is now able to draw a detailed picture of the biology of these remarkable bees, but this would not have been possible without the co-operation of several enthusiastic collectors in the field, each of whom has contributed hundreds of specimens and many "nests", together with a number of helpful observations. The author desires to place on record his appreciation of their conscientious endeavours.

The late J. E. Dixon, an old and respected fellow-member of the Field Naturalists' Club of Victoria, was the first to bring a twig of dry *Melaleuca ericifolia* from Frankston, Victoria. He said it had contained a nest of *Exoneura,* but did not know which species had bored the stem; only the empty gallery remained; circa 1930.

In 1935, John Hardcastle, Junior, White Swamp, on the border of New South Wales and Queensland, forwarded a nest of *E. perpensa* Ckll., but only adults were present in the twig, which had been cut from "brush box", *Tristania conferta.* In the same year, R. Willey, Woy Woy, New South Wales, collected a plant-stem occupied by imagines of *E. hamulata* Ckll. No larvae were present in either of these "nests".

Alex. Holmes, editor of the magazine "Bird World", Woollahra, New South Wales, sent a twig of *Banksia* containing eggs, larvae, and imagines of the species that bears his name. That was in 1940; the first record of the larvae.

In 1944, Norman Rodd, Lane Cove, Sydney, New South Wales, went into the field and was very successful in collecting twigs containing galleries, eggs, larvae and adults of several species of *Exoneura,* especially *E. roddiana* Raym.

In the same year, Owen Dawson, on service with a radar unit, R.A.A.F., began to search for reeds and sticks drilled by these bees, and he, too, found the "nests" of several species, each of which contained eggs, larvae and adults. Newton Lawson, Canberra, Federal Territory, also sent a "nest" about that date.

The author himself had collected the nesting galleries of several species during his excursions into the other States of the Commonwealth, and Rica Erickson, Bolgart, Western Australia, also found many twigs about 90 miles north of Perth.

In October, 1948, C. E. Chadwick, entomologist, Department of Agriculture, Sydney, New South Wales, discovered a series of "nests" in galls, all of which were taken at Bradfield Park, near Sydney, and these proved to be occupied by *E. concinnula* Ckll.

It will be seen, therefore, that the research has extended over many years, and it is now known that the *Exoneurae* are very remarkable bees, not only because of the unique appendages—like "arms" and "hands"—of the larvae, but also for the communal cell, which also is unique, and the progressive feeding of the larvae with a glandular secretion by the adults over a long period. The sharing of the work among several sisters undoubtedly elevates the genus to a social status, although the members of the family are few in number. *Exoneura,*

then, occupies a position between the populous social bees *Melipona* and the solitary wild bee *Lestis,* which remain at the original nest until the progeny emerge. The former bee builds wax cells, the latter nests in plant-stems.

Kerr (1946) demonstrated that in *Melipona,* an American genus of comb-building social bees closely allied to the Australian *Trigona,* the castes are due to genetic factors, and not to differences in food. There are no specialised cells, not even for the queen. In *Exoneura* there are no castes and no cells, only the two sexes.

The author's researches in the Hymenoptera are assisted by a Grant from the Trustees of the Commonwealth Science and Industry Endowment Fund.

Systematic Position.

Order HYMENOPTERA. Suborder HETEROPHAGA.

Division XYLOCOPIFORMES.

Superfamily APOIDEA. Family CERATINIDAE.

Genus *Exoneura* Smith.

Exoneura Smith, Cat. Hym. B.M. ii., p. 232, 1854. Genotype, *E. bicolor*. *Id.* Cockerell, Ann. Mag. Nat. Hist. (7), xvi., p. 465, 1905; Aust. Zool. vol. vi., pt. ii., pp. 148 and 153, 1930; *Id.* Rayment, A Cluster of Bees, p. 476, 1935.

Morphology.

Small, soft-bodied bees, with a smooth shining integument; a long slender glossa; often with ivory-coloured marks on the clypeus; anterior wings with only one recurrent nervure. The majority of the species have a black head and thorax and a red abdomen, but there is a group entirely black. The bees have little pubescence, but the males are, anomalously, often more hairy than the females.

Cockerell (1930) regarded *Exoneura* as an Australian derivative from the African *Allodape*. "It is an example of an Australian genus which is less primitive than its relatives in the other parts of the world." The present research demonstrates that the larval appendages have a parallel in the African genus; there is a long-continued progressive feeding of the larvae, and the bees are truly social in habit.

The smallest of the described species is *E. parvula* Raym., which is only 3.5 mm. in length, with a black head and thorax and a red abdomen. It was described from Marysville, Victoria (F. E. Wilson), but it has since been taken near Sydney, New South Wales (Alex. Holmes).

Another small bee, *E. ploratula* Ckll., is 4.5 mm. in length, and entirely black, having no pale markings on the "face". W. W. Froggatt, the well-known entomologist, Sydney, collected it on flowers of *Angophora*. *E. botanica* Ckll. is another small, all black species, only 4.5 mm. in length. *E. gracilis* Ckll. described from Queensland (H. Hacker) is very small.

The largest *Exoneura* described is *E. grandis* Raym., and this belongs to the group with a black head and thorax and a clear ferruginous-red abdomen. It measures 10 mm. in length, a fine robust species without any pale markings on the "face". The type was collected by the author on flowers of the bramble, at Caulfield, Victoria.

Clarence Borch and Erasmus E. Wilson, both of the Field Naturalists' Club of Victoria, obtained several "new" males by sweeping with a net over bracken ferns in the Grampians Range, Victoria, and *E. xanthoclypeata* Raym. and *E. bicincta* Raym. were also obtained in this way.

Although the genotype, *E. bicolor* Smith, was described from Perth, the author has few *Exoneurae* from Western Australian, only four species, whereas the

related genus, *Allodapula* Ckll. is much better represented in the areas of low rainfall. *Neoceratina* Perk. is comparatively rare, and so far has been taken only in New South Wales.

Specific Description.

Exoneura angulata, sp. nov.

Type: Female. Length: 7 mm. approx. Black, with red abdomen.

Head black, with the parts angulated from eyes down to antennae; from antennae up to carina of frons; clypeus lying as a low plane, so that the whole face is excavated, but on different planes, and is very distinctive; clypeus suffused with reddish, some minute punctures; supraclypeal area forming the base of the excavation; vertex with large angulated areas above the compound eyes which converge slightly below; node-like swellings surround the ocelli; a few smoky hairs; genae with a microscopic lineation; even the genae are angulated apically; labrum suffused with red; mandibulae reddish, darker apically and basally; antennae black, obscurely brown beneath on apical half.

Prothorax with a few white hairs; tubercles black, with an ochreous fringe; mesothorax black, polished, with an excessively delicate tessellation, a few large punctures, and very scattered smoky hairs; scutellum similar; postscutellum rougher; metathorax black, with a comparatively coarse scale-like sculpture; the pleura have the most hair, which is ochreous on the polished plates; abdominal dorsal segments clear chestnut-red without any black markings, apical hair black and bristly; ventral segments red.

Legs black, femora apically, tibiae and tarsi all of a darker red, with much black hair on the hind tibia, otherwise the hair is golden, especially the tufts on anterior coxae; tarsi red, with golden hair; claws red; hind calcar red, much curved; tegulae reddish, with blackish suffusion; wings slightly yellowish, long, very iridescent; nervures sepia; second cubital cell greatly contracted at apex; pterostigma dark-brown; hamuli five, weak, unevenly spaced.

Locality: Dandenong, Victoria, 2nd November, 1948. Owen Dawson.

Type in the collection of the author.

Allies: *E. excavata* Ckll., which is larger and darker red; *E. subexcavata*, sp. nov., which has a bright yellow T on the clypeus.

By the structure of the larvae the new species is close to *E. richardsoni*, sp. nov., which was nesting in close proximity in the garden of W. R. Richardson, Esq., at Essex Park. The larva of *albolineata* Ckll. has two large "arms" laterally, each with two "fingers", *E. angulata* has only one "arm" laterally.

Exoneura subexcavata, sp. nov.

Female: Length, 7 mm. approx. Black, with red abdomen.

Head transverse, polished black; face-marks creamy-yellow; frons deeply excavated around antennae; clypeus with a yellow, thick "T", on some specimens the stem is as wide as the bar; supraclypeal area rising to a fine carina that reaches the median ocellus; vertex with a few griseous hairs; compound eyes converge slightly below; genae similar to mesothorax; labrum reddish; mandibulae reddish; antennae black, obscurely lighter beneath.

Prothorax not visible from above, black; tubercles yellow, with fringe of white hair; mesothorax shining, black, a delicate sculpture, scattered punctures, sparse hair; scutellum and postscutellum similar; metathorax black, sculpture more defined; abdominal dorsal segments red, dusky at apex, with a few dark hairs; ventral segments somewhat darker.

Legs red, coxae, trochanters and extreme base of femora black, hair yellowish, except exterior of tibiae, where it is blackish; tarsi with golden hair; claws reddish;

hind calcar amber; tegulae amber; wings yellowish; nervures sepia; cells normal for genus; pterostigma amber; hamuli five, very weak.

Locality: Emerald, Dandenong Ranges, Victoria (8th December, 1934, Owen Dawson and Rayment).

Type in the collection of the author.

Allies: *E. abstrusa* Ckll., the contour of the face of which is different, since it lacks such large excavations. *E. excavata* Ckll., which has no yellow face-marks, but closest to *E.* [*a*] *simillima* Raym. 1.

On flowers of *Leptospermum* species.

Exoneura albolineata Cockerell.

(Records of the Australian Museum, vol. xvii., No. 5, Sept., p. 241, 1929.)

A long series of "nests" built in dry stems of garden Dahlia and Hydrangea, Bramble and Rose, at Dandenong, contained many nursing females, and it was observed that the pale markings of the face varied in the females of the same nest.

The lateral marks may be broad and long, narrow and short, and on some specimens reduced to mere dots, while the "T" of the clypeus may be bright yellow and clear, but in some the mark is subobsolete, and one bee had an entirely black face. Determination is complicated by the fact that two species will occasionally shelter amicably in one twig during inclement weather, and there is some evidence that they work together in the rearing of the brood. The type female has black legs, and these southern females have red legs, and they lack the black basal patch and bands on the abdomen, although the male has the basal black mark. The Victorian bees may be known as *E. richardsoni,* sp. nov.

Exoneura richardsoni, sp. nov.

Type, Male: Length, 5 mm. approx. Black, with red abdomen.

Head polished, transverse; lateral face-marks large, ivory-coloured, shaped like a eucalypt leaf, filling the space between the clypeus and the orbital margin; frons excavated about the scapes, but rising to a median ridge, with its base on the black supraclypeal area, the ridge becomes bifurcate at the median ocellus; vertex with a few smoky hairs; ocelli large; compound eyes bulging, converging below; genae large for the genus, microscopically lineate; labrum ivory, a few white hairs; mandibulae ivory; antennae black, scapes ivory in front.

Prothorax black, prominent, with numerous white hairs; tubercles black, with a fringe of dense white hair; mesothorax smooth, shining, with an excessively delicate tessellation; scutellum and postscutellum similar; mesothorax with a coarser tessellation, and considerable white hair laterally; pleura shining, with much long loose plumose hair; abdominal dorsal segments clear ferruginous red, a black patch on the basal one, a few dark bristles apically where the red is somewhat darker; ventral segments similar.

Legs of the same clear bright red, with black coxae, and trochanters partly black, hind tibiae and basitarsi excessively stout, with black bristles on the outer surface, the femora with much long white hair; tarsi red, with some pale hair; claws red; hind calcar, tegulae and axillae amber; wings yellowish, iridescent; nervures dilute sepia, the first recurrent received by the second cubital cell at its anterior fifth; second cubital cell contracted above to half the width of the base; pterostigma large, dark-brown; hamuli five, weakly developed.

Localities: Narre Warren, Victoria, September, 1950, Owen Dawson. Dandenong, Victoria, 5th November, 1948, Owen Dawson and Rayment.

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1. The initial "A" was omitted from the specific name in the original description. See "Victorian Naturalist", Vol. 65, pp. 208-212, Jan., 1949.

Type and allotype in the collection of the author.

Allies: This male is easily separated by its remarkably stout hind legs, especially the broad basitarsi which, strangely enough, have an oval suturiform mark apically, and similar to that of the anterior leg of the primitive wasps *Guiglia queenslandensis* (Turner) in the Family Oryssidae.

The sexes were not taken *in cop.*, but the male was sheltering with a number of females, and it agrees structurally with them. Like certain other species of *Exoneura* the male has more hair than the female.

The type of *E. albolineata* Ckll. was described from Dorrigo, New South Wales, but that has long lateral marks on the face.

Larva: There are eleven appendages along each side of the larva, and there is a second row of very minute nodes on the ventral surface, so that each segment bears four nodes; the first is the smallest node; the second is the largest "arm" with three "fingers" and a stout "thumb"; third with two small "fingers"; fourth, fifth, sixth, seventh and eighth have small nodes, but the ninth, tenth and eleventh have long slender "fingers".

The larva of *E. albolineata* Ckll. has only three "fingers" on the largest appendage, and the second lacks the basal "finger" of the new species; the fourth, fifth, sixth, seventh and eighth have long "fingers", *not* small nodes. These differences warrant full specific rank.

Description of Male, *E. rufitarsis* Raym.

(Aust. Zool., vol. xi., part 3, p. 253, 1948.)

Allotype, Male: Length, 5 mm. approx. Black.

Head almost circular from the front; shining bright; face-marks deep ivory-yellow; frons with a fine high carina that reaches the basin surrounding the median ocellus; clypeus ivory-yellow, the apex widely truncated, but laterally the yellow is indented at the tentorial pits, but expanded basally; a few white hairs; supraclypeal area black; vertex with a few long pale hairs; compound eyes bulging, converging below; genae finely lineolate, a few pale hairs; labrum yellow, with scattered black dots; mandibulae black, simple, an obscure median amber patch (the female has three small teeth); antennae black, scapes obscurely yellow on a front line, a few long white hairs.

Prothorax with a few pale hairs; tubercles ivory-yellow, with a dense fringe of white hair; mesothorax shining bright, finely lineolate, a few short white hairs about the margin; scutellum similar; postscutellum rougher; metathoracic area large, coarsely tessellate, a few white hairs laterally; abdominal dorsal segments transversely finely lineate, a few coarse pale bristles; ventral segments similar.

Legs black, anterior and median tibiae largely red; the hind tibiae blackish; tarsi all red, the hind ones darkest, a few pale hairs; basitarsi with fine black dots; claws reddish-amber, a large empodium; hind calcar amber; tegulae shining black; wings hyaline, rather broader than usual, iridescent; nervures blackish-brown, strong, first recurrent entering the second cubital at its basal sixth; cells: second cubital contracted apically to half its width; pterostigma large, blackish-brown; hamuli four, very weakly developed.

Localities: Clyde, Gippsland, Victoria, 13th July, 1948, Owen Dawson; Dandenong, Victoria, 3rd November, Owen Dawson and Rayment.

Allies: Dissection of two males shows that it is very close to *E. roddiana* Raym., which is smaller; the female having red scapes, and the male black, the reverse of what persists in *E. rufitarsis*. The clypeal stripe is conspicuous on the female of *E. roddiana*, but practically obsolete in the new species. The larvae of both have only one "finger" on the "arm". *E. roddiana* was described from Lane Cove, New South Wales. (See plate xxx., figs. 5 and 25.)

Methods and Materials.

The author used the following methods quite successfully. A dry twiggy branch of tea-tree, seven feet tall, was set up in a sheltered, warm, unfrequented part of the garden, and firmly secured to a couple of stout stakes. Dry stems of rose, hydrangea and bamboo were cut into lengths of about 25 centimetres. These had a diameter of 8 millimetres, and were tied vertically on the branch.

Larger stems were utilised, and a coarse knitting-needle thrust down into the pith, and into these cavities the original tubes containing the *Exoneura* "nests" were gently inserted without disturbing either the bees or the larvae. The original tubes should first be split carefully, and the two pieces put neatly together again before placing in the protective stem.

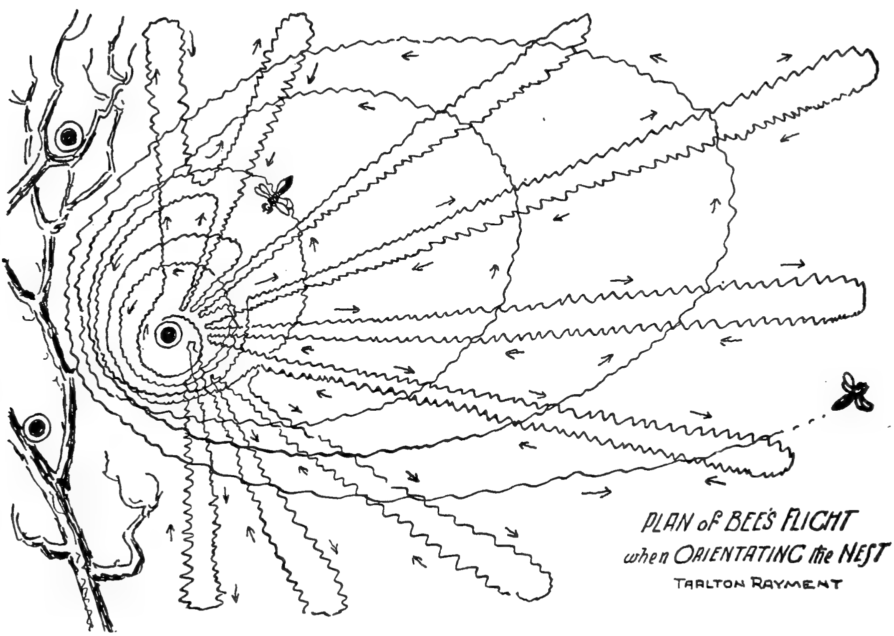

Fig. 1: Plan of the orientating flight of *Exoneura rufitarsis* Raym. The projecting dry twigs of the shrub preclude a circular course.

It is advisable to wind a few strands of wool, soaked in carbolic acid and oil, round the base of the branch to repel ants, for these pests will sometimes raid the nests of the *Exoneurae,* and carry off eggs and larvae should the nest be temporarily unguarded.

For continuous observation under a lens, thin tubes of plastic, blackened longitudinally, were used as "sleeves", which could be rotated to expose a slit in the nesting twig, or reversed again to exclude light. The end was closed with a plug of porous pith, through which a fine needle hole provided a trifle of ventilation; very little air is needed.

Using these simple arrangements, the author kept families under continuous observation for several weeks without detriment to either the adults or the larvae. Of course, a pollen-pudding must be provided for the adults, and the amount of honey used must not reduce it to a sticky mass, for then the females walk over it

and become incapacitated when the spiracles are clogged with the honey. The author experimented with his synthetic pollen and achieved some success, and he also supplied fresh pollen from the combs of the honeybee, and the larvae ate both kinds. A piece of pollen as large as a pea will be ample provision for a fortnight for a small family.

Localities

The "nests" of *E. rufitarsis* Raym. were obtained from Clyde, Gippsland and Dandenong, Victoria. The former district is thirty or so miles south-east of Melbourne, and six miles north of Tooradin, at the head of Western Port Bay. Geologically, the district is just within the old Red Sands of Sandringham, and which run on a finger-like extension through Cranbourne, 2½ miles west of Clyde. The extensive swamp-lands at Koo-Wee-Rup are only a few miles to the east, the contours, then, are flattened out.

The two or three hills of golden-yellow sand are probably old dunes, and there is a quarry which had been worked for the dark-red marl. Strangely enough, this material is known locally as "gravel", and its colour is, of course, due to the presence of iron. The red marl was used in many districts in the Red Sands area to dress roads and pathways. A very numerous colony of *Nomia australica* was studied in the marl, and its biology is awaiting publication.

The actual site of the colonies of *Exoneura rufitarsis* is on the margin of a swampy flat carrying a dense growth of low "manuka" tea-tree, *Leptospermum scoparium* and woolly tea-tree, *L. lanigerum,* say, four or five feet tall. On the higher levels is a number of needle-bushes of several species, such as *Hakea ulicina, H. nodosa* and *H. sericea;* the prevailing eucalypt is *E. viminalis.*

Seven "nesting" sticks were cut from a strong plant of golden spray, *Viminaria denudata,* which has a broom-like appearance, having more sticks than leaves, and, in summer, bearing masses of golden-yellow pea-shaped blooms; it is, of course, in the Family *Leguminosae.* Twenty-eight "nests" were taken at Dandenong during 1948.

Green twigs have no attraction for any bees, for the moisture in the sap favours the growth of moulds; consequently, only dry stems are utilised for "nesting". The sticks were about the base of the plant, at a height of from one to about three feet from the ground.

The 13th of July, 1948, was very cold, and the collector could not discover any flowers within a radius of half a mile of the "nests", but beyond that distance he found a wattle, *Acacia armata,* and a hedge of tree-lucerne, *Cytissus proliferus-albus,* in bloom. However, the *Exoneurae* must have done better than the collector, for the triangular pollen-grains of some myrtaceous plant; thorny spherical ones from a composite, and plain spheres from some unknown source, were present in the ventriculus of the larvae, and they are quite different from the grains of the other two plants. How far the bees had to fly to reach their harvest could not be ascertained.

Flowers Used by Exoneurae.

The bees have been taken in the field on many botanical species, and, like the hive-bee, thrive on a diet of mixed pollens. Whether or not they are constant to one plant on each harvesting journey has not been determined, but microscopical examination of the scopae on homing bees seldom reveals an admixture of pollen-grains. What little contamination is present may be accidental.

The females have a scanty pubescence; the most conspicuous are the branched hairs forming the scopae of the posterior legs; there is most hair on the femora and tarsi, and a few hairs on the gaster, but the bulk of the pollen is enmeshed in the scopae. However, there are never at any time any large loads visible on the legs.

In all the many "nests" investigated by the author, he has never found any store of either honey or pollen, other than small individual puddings. The author has recorded that whereas the *Anthophorae* frequent a large number of botanical species introduced from overseas, the *Exoneurae* definitely prefer the native plants, and this would seem to indicate the arrival of *Anthophora* in Australia at a comparatively recent date.

The following list of plants was compiled by the author and his collectors, and it has been checked by Messrs. P. F. Morris and J. M. Willis, National Herbarium. The author is indebted to these botanists for their co-operation:—

Family	Species	Locality	State
PITTOSPORACEAE	*Bursaria spinosa*	Hall's Gap	Victoria
,,	,, ,,	Mordialloc	Victoria
,,	,, ,,	Launceston	Tasmania
CARYOPHYLLACEAE	*Stellaria media*	Lane Cove	N.S.W.
LORANTHACEAE	*Loranthus* sp.	Gosford	N.S.W.
CRUCIFERAE	*Alyssum* sp.	Lane Cove	N.S.W.
GOODENIACEAE	*Goodenia ovata*	Grampians	Victoria
RUTACEAE	*Boronia pilosa*	Grampians	Victoria
ROSACEAE	*Rubus fruticosus*	Neerim	Victoria
,,	,, ,,	Oakleigh	Victoria
,,	,, ,,	Emerald	Victoria
,,	*Rubus* (Loganberry)	Neerim	Victoria
LEGUMINOSAE	*Acacia pycnantha*	Grampians	Victoria
,,	*Genista* sp. (Broom)	Macedon	Victoria
,,	*Dillwynia ericifolia*	Black Sands	Victoria
,,	*Platylobium formosum*	Emerald	Victoria
,,	,, *obtuseangulum*	Grampians	Victoria
,,	,, *Gunnii*	Emerald	Victoria
,,	*Daviesia* sp.	Grampians	Victoria
MYRTACEAE	*Callistemon* sp.	Frankston	Victoria
,,	*Angophora cordifolia*	Como	N.S.W.
,,	*Eucalyptus* sp.	Como	N.S.W.
,,	,, ,,	Bundeena	N.S.W.
,,	,, ,,	Neerim	Victoria
,,	,, *corymbosa*		Victoria
,,	*Kunzea ambigua*	Como	N.S.W.
,,	*Calytrix sullivanii*	Grampians	Victoria
,,	*Leptospermum arachnoideum*	Mt. Colah	N.S.W.
,,	,, *flavescens*	Como	N.S.W.
,,	,, ,,	Heathcote	N.S.W.
,,	,, *walkeri*	Toorak	Victoria
,,	,, *walkeri*	Dandenong	Victoria
,,	,, *scoparium*	Emerald	Victoria
,,	,, *myrsinoides*	Grampians	Victoria
,,	,, ,,	Emerald	Victoria
,,	*Melaleuca ericifolia*	Frankston	Victoria
,,	,, ,,	Cranbourne	Victoria
,,	,, *decussata*	Grampians	Victoria
,,	,, *squarrosa*	Grampians	Victoria
,,	*Tristania conferta*	White Swamp	N.S.W.
LOGANIACEAE	*Logania floribunda*	Lane Cove	N.S.W.
UMBELLIFERAE	*Trachymene* sp.	Lane Cove	N.S.W.
VERBENACEAE	*Avicennia officinalis*	Cook's River	N.S.W.
LABIATAE	*Prostanthera lasianthos*	Emerald	Victoria
EPACRIDACEAE	*Leucopogon* spp.	Sandringham	Victoria
PROTEACEAE	*Banksia* sp.		N.S.W.
,,	*Grevillea buxifolia*		N.S.W.
,,	,, *sericea*		N.S.W.
,,	*Lomatia* sp.	White Swamp	N.S.W.
STYLIDIACEAE	*Stylidium graminifolium*	Mt. Buffalo	Victoria

Fig. 1

RUBIACEAE	*Plectronia attenuata*	Edungalba	Queensland
COMPOSITAE	*Aster subulatus* (Intro.)	Lane Cove	N.S.W.
,,	*Hypochaeris radicata*	Inverloch	Victoria
,,	*Olearia ramulosa*	Grampians	Victoria
,,	,, ,,	Emerald	Victoria
,,	*Taraxacum officinale* (Intro.)	Toorak	Victoria
,,	,, ,,	Sandringham	Victoria
,,	*Shasta Daisy*	Dandenong	Victoria

ARCHITECTURE.

The majority of the "nests" investigated by the author have been in twigs, reeds, ferns or other plant-stems containing a soft pithy core. In every case the pith had been exposed, and in not a single instance was the fibrous woody wall attacked to effect an entry. The sticks are always vertical and quite dry, and the entrance invariably at the top. *Exoneura concinnula* occupied galls.

There is commonly an "iris" of wood-pulp constructed to reduce the diameter of a tube that is too large, and this ring near the "door", say, 2 mm. in thickness, is the only evidence of worth-while constructive craft; the rest of the work is a mere crude excavation of soft pith. At the base of the shaft there is sometimes a plug of thin parings, but the work is exceedingly elemental. No attempt is made to build any cell-divisions, for the interior of the plain tube is utterly devoid of cells, and consists of a true communal cradle shared by all, eggs, larvae, pupae, adult males and females. There is not a trace of any containers for food. When a couple of nests were built in a dry fern-frond, the galleries meticulously followed the soft pity core, and where a harder line of woody fibre was encountered, the bees either went round it, or else ceased work at the obstacle. In places only the thinnest woody wall separated the two galleries, yet it was never once pierced by the bees.

It will be observed from the list of plant-stems utilised that only the softest of pith is excavated, and hard kinds are utterly neglected. One concludes that the bees are incapable of manipulating any stubborn material, for the small mandibles are not strongly formed, and their musculature is weak.

The twigs favoured by *E. rufitarsis* Raym. were of "Golden Broom", *Viminaria denudata,* and since seven "nests" were found on one plant, it would seem that the families prefer to labour in close proximity to each other.

That the *Exoneurae* do not invariably seek pithy twigs, in which to establish their communal chambers, was demonstrated by Mr. C. E. Chadwick, entomologist, Department of Agriculture, Sydney, who forwarded a series of galls which had been formed on the stems of *Pultenaea stipularis* Sm. by the Buprestid beetle *Ethon* (probably the species *affine* Laporte and Gory); collected at North Shore.

These woody enlargements of the vegetable tissue were approximately 25 mm. in length, by 18 or so mm. broad, of irregular shape, but roughly subspherical, and each contained a cavity, more or less resembling a short wide tunnel. The wall was dark and hard, much too hard for the weak jaws of an *Exoneura.* The cavities were undoubtedly the work of the original tenant.

It was evident from this gall series that the bees in possession had made no attempt whatever to excavate the woody material, but had in every case used an entrance through a small hole which led to the interior—probably the exit hole. The interior walls were granular rather than smooth, and there was little, if any, draping with silky secretion to make them more acceptable, and no pithy structure could be found in even the normal twigs of the plant.

The collector observed that the interior of abandoned galls is usually cluttered with much frass left by the original tenant, but the *Exoneurae* are thorough in their house-cleaning, and every fragment is meticulously taken out before they "settle in". The rubbish is removed with the mandibles.

The cylindrical eggs of the bees were attached to the wall by the usual agglutinative at the caudal pole, and the oldest larvae possessed appendages very similar indeed to those of the black species, *E. rufitarsis* Raym., that is, only one "arm", with a single "finger", is present on each side. There are not any abdominal nodes.

This is the first record of the nest and the larvae of *E. concinnula* Ckll., and it is even more evident that the species in this genus can be separated satisfactorily only after a study of the larvae and their appendages. This series of nests contained several eggs and fully developed larvae in October, and the biological cycle appears to conform to the typical pattern, a brood nursed by several sisters, in a communal cradle. The young larvae are fed over a lengthy period with a secretion of the pharyngeal glands, and later each larva receives its own individual pollen-ball. The excreta are ejected in three or four small single pellets, each less than 1 mm. in length, at 20-hour intervals.

These bees belong to the group with a red abdomen and an entirely black face, and are typical *Exoneura concinnula* Ckll. It was observed that several of the oldest larvae were lying criss-cross at one end of the chamber, without order, but this may have been due to shaking during transit in the mails.

However, this record is interesting, because it shows the adaptive character of the bees, and although the collector thought that the high sugar content of the galls may have attracted the bees, the author considers that this has no bearing on the bees' choice—the galls were merely suitable cavities, but if it be demonstrated in the future that these bees prefer the galls, then it is possible that some selective factor is involved.

In any case, the cavities in the galls are very small, and would be quite inadequate for a numerous brood. It is significant that only one or two females were present in each gall, and the largest number of larvae and eggs taken from any gall was only six. The following table demonstrates the restricted character of the "nests":—

No. of Gall	Length of Cavity	Diameter	Contents
1.	13 mm.	5 mm.	1 adult, cleaning interior
2.	12	4	1 adult, 1 egg, 5 larvae
3.	18	4	1 adult
4.	18	4	2 larvae, 1 adult
5.	20	5	2 larvae, 1 adult
6.	18	5	1 Acarid mite, 2 larvae
7.	17	4	1 full-grown larva
8. By collector	18	4	3 old and 3 young larvae, 2 eggs
9. By collector	17	3	2 old larvae, 3 eggs

The *Exoneurae* are singularly free from Acarine parasites, but No. 6 gall contained a milky-white mite, which did not do more than clamber aimlessly over the wall of the chamber. Mites are exceedingly numerous in the nests of the earth-digging halictine bees (Rayment, 1935), and have an important function in maintaining the nests in a sanitary condition, but the amount of excretal debris in *Exoneura* nests is very small indeed. The above mite proved to be a European species, *Tyrofagus tenuiclavus;* the first record for Australia.

The collector sends a note stating that he found an entirely black bee in one nest, but dimorphism must be exceedingly rare in the genus, for although the author has examined many hunreds of *Exoneurae* he has not yet observed this phenomenon. It is known that individuals of two or more species will sometimes congregate in a nest for shelter, and perhaps "mutual comfort", but this habit of seeking the company of relations is strongly developed in many genera, but especially in *Paracolletes, Halictus, Nomia, Anthophora, Asaropoda,* and, of course, the hive-bee *Apis,* for it is the element of the swarming instinct.

The largest "tube" in any plant stem measured 31 cm. in length in a twig 9 mm. in diameter, the bore having a diameter of 3 mm.; the smallest sticks are only 5 mm. in diameter, so that the external walls are extremely thin.

Exoneura hamulata Ckll. is a larger bee, consequently its tube has a diameter of 4 mm.; however, the majority of the species make a bore about 3 mm. and, in a few tubes, there was a blackish skin wad, very thin, at the base, and it may have been formed of discarded larval skins.

Plant-stems Bored by Exoneurae.

Common Name	Specific Name	Locality	State
Banksia	*Banksia serrata*	Heathcote	N.S.W.
Bottlebrush	*Callistemon* sp.	Frankston	Victoria
Blackberry	*Rubus* sp.	Dandenong	Victoria
Brush Box	*Tristania conferta*	White Swamp	N.S.W.
Dahlia (Garden)	*Dahlia* sp.	Dandenong	Victoria
Coral-tree	*Erythrina* sp.	Lane Cove	N.S.W.
Golden Spray	*Viminaria antarctica*	Neerim	Victoria
,, ,,	,, *denudata*	Cranbourne	Victoria
Grass-tree	*Xanthorrhoea hastilis*	Fraser Park	N.S.W.
,,	,, ,,	Lane Cove	N.S.W.
,,	,, *minor*	Lane Cove	N.S.W.
Hydrangea (Garden)	(Introduced)	Mt. Macedon	Victoria
,, ,,	,,	Lane Cove	N.S.W.
Lantana	,,	Patonga Beach	N.S.W.
,,	,,	Lane Cove	N.S.W.
Paper-bark	*Melaleuca ericifolia*	Frankston	Victoria
Rush Giant	*Juncus pallidus*	Grampians	Victoria
Rose (Garden)	*Rosa* sp.	Dandenong	Victoria
Snow Daisy-bush	*Olearia lirata*	Neerim	Victoria
Spear Grass or Saw Sedge	*Gahnia tetragonocarpa*	Grampians	Victoria
Tree-fern	*Dicksonia antarctica*	Neerim	Victoria
Wandoo	*Eucalyptus redunca*	Bolgart	W.A.
Wattle	*Acacia* sp.	Lane Cove	N.S.W.
Wild Parsnip	*Didiscus pilosus*	Clyde	Victoria
,, ,,	*Spartium junceum*	Cranbourne	Victoria
	,, ,,	Lindfield	N.S.W.
Galls (not bored)	*Pultenaea stipularis*	Sydney	N.S.W.

Larval Development.

Critical examination of a large series of plant-tubes shows that in the black species *E. roddiana* and *E. rufitarsis* the eggs are attached to the wall, and project into the lumen at right angles, being fastened at the caudal pole with a clear agglutinative, a secretion of two glands in the apical segments of the female abdomen. The "gum" is exceedingly tough, and attaches the egg very firmly indeed to the wall.

The egg is rather broader in proportion than the average of bees' eggs, but little bowed and milky-white, measuring 1,200 microns at the long axis, and 433 microns at the short, which is a large egg for so small a bee.

An egg of *E. perpensa* Ckll., measured just before hatching, reached the extreme of 2,100 microns at the long axis, and 500 microns at the short. Since the "fresh" egg of this species is about the same size as that of *E. rufitarsis,* they undoubtedly increase in length just before hatching, and by transmitted light, the developing embryo may be seen as an opaque patch in the large mass of the clearer yolk, the deutoplasm. The beautiful hexagonal sculpture, which is so conspicuous on the chorion of the egg of the honey-bee, is not evident on the egg of *Exoneura.* The eggs of the red-bodied *E. concinnula* are attached in a similar manner, but are widely separated, in no particular order, and only two or three are present.

The eggs of *E. rufitarsis* are disposed along a slightly spiral line, and spaced approximately a millimetre apart. They are deposited generally in groups, although there may be only a single egg, or as many as eight. Although more often than not, in such a case, three or four of the eggs have hatched, without altering the original position; six is the commonest number.

In certain of the red-bodied species, such as *E. angophorae* Ckll., the eggs, a dozen or so in number, may be deposited criss-cross in a mass at the base of the chamber, on a communal store of crumbly pollen, and the larvae appear to be able to mount the wall, and attach themselves by the long-pointed "tail". The author had several in an experimental wooden cell, and, during the night, they "climbed" out, thus providing evidence of the larval ability to travel to a new position. Some of the red-bodied group also deposit their eggs in a line.

Several "nests" of *E. rufitarsis* were under constant observation, and at a temperature of 10 deg. C. none of the eggs showed any observable change until the 1st of August, when the merest traces of segmentation were to be seen under a lens. These eggs were probably deposited on the 12th of July, so that 20 days had elapsed. Rodd recorded about 18 days in the warmer climate of Sydney. This is a very long period compared with the three days of the honey-bee in the warmth of the beehive, i.e., 35 deg. C.

Very young larvae showing short "arms", and which were very probably 21 days old on the 12th of July, did not make any evident growth by 1st of August, although they had been constantly attended, nursed and fed with secretion by six females present in the stem. The larvae consumed food throughout Steptember.

The appendages showed signs of being absorbed about 1st October, and had disappeared by 12th October. The pupae were recognisable as such about the 27th October, but at that date they were entirely white, and the compound eyes did not show any colour until 6th November. The bees were finally pigmented and ready to emerge as imagines on 5th December.

The temperature in the field, for the first half of July, 1948, seldom exceeded 12 deg. C., for the the winter was a severe one, and the lower readings established a record. Night temperatures were, of course, much lower.

The egg appears to merge almost imperceptably into a segmented larva, for only the smallest trace of a twisted white "thread" remains to represent the original chorion of the egg. The strange-looking creatures project like tiny crosses from the wall; the "cross-arms", of course, being the short appendages which soon appear. As the larvae grow they ascend the walls, and dispose themselves at regular intervals according to their age; the oldest always being at the higher end of the chamber, nearer the entrance. It was seen that the adults frequently "brush by" the larvae, even pressing them temporarily "flat" against the wall, but they swing back into their original position immediately the mother passes.

The eggs are deposited by the several sisters inhabiting the tube, and large numbers of eggs have been counted in one tube when eight or so females were present. (See under heading—"Behaviour of the Individual.") Usually it is found that where three females are present there will be eighteen or so eggs. (Compare the limited number of eggs in *E. concinnula* Ckll.)

On the 12th July, 1948, a twig of *Viminaria,* from Clyde, contained the following bees in a cavity 20 cm. deep, seven females, ten males, twelve larvae, but no eggs.

In a fern-frond bored by *E. hamulata* Ckll twenty-six larvae and eleven eggs were taken from two "nests", together with nine females; no males were in the series, but that is not the usual condition, for several males are more often than not present in the chamber.

The larval appendages provide the best specific characters. Some species, such as *E. rufitarsis* and *E. roddiana,* have only one "arm", terminating in a slender "finger", and are very distinctive.

Exoneura angulata Raym. is a distinctive species with much black hair on the hind legs like *E. angophorae,* but that bee has black on the abdomen. However, it is easily known from all others by the angulated "face". It was bred from dry stems of the garden *Hydrangea,* and several females were present to attend to the numerous larvae which were lying together in a squirming mass

at the base of the chamber. Each of the larvae had its own individual pudding of pollen. There were 17 larvae and six eggs in one "nest" with several female adults.

On cutting a sliver from the stem to expose portion of the interior, a female immediately ran forward, and carried a larva back to shelter. She repeated this manoeuvre several times until all the larvae had been taken under cover. (See Chadwick's observation under "Behaviour".) This species apparently feeds pollen very early.

The fully developed larvae resemble those of *E. richardsoni* Raym. in having a large number of abdominal nodes, although they are shorter, and it would appear that *angulata* and *albolineata* are allied. The thoracic appendages are different, and a description of the larva is appended.

The fresh egg is typical, but a trifle longer, 1,500 microns at the long axis and 500 microns at the short.

The larvae are of a bright pale-orange colour, and when curled tightly measure 3 mm. in diameter; when fully fed and straight, nearly 6 mm. in length. They have a strong instinct to cluster together and squirm about each other. There are eleven appendages on each side. The first is the longest, one "arm" with one exceedingly long "finger", and two short "fingers", then six short abdominal nodes, next one longer, then two very long, and a shorter one. There is an inner row of microscopic tubercles.

Even the very small larvae were pale-orange, and it was evident that they had consumed some pollen, for it was visible in the mesenteron. Seventeen or so were transferred to bee-hive pollen mixed with "royal jelly" on 3rd November, 1948, but all failed to pupate.

Contrary to the opinion expressed by the author in 1948, he is now convinced that the so-called pseudopodia are actually exudatoria, as Rodd suggested, for he has observed in two species at least, *E. richardsoni* Raym. and *E. angulata* Raym., the larvae apparently sucking the many nodules and appendages.

At times the *two* "thumbs" of the largest appendages of *E. angulata* are in the mouth together, but most often only one is sucked at a time, and may be held in the mouth for a long period—two minutes or so.

The larvae swallow a few "mouthfuls" of pollen mixture, and then stretch themselves vigorously and quickly backwards three or four times as though endeavouring to "force' 'the pollen down into the mesenteron. They just as quickly contract several times into a circular bend as though struggling to reach the longer hind processes with the mouth. This exercise is a common and frequent action, and occurs after every few mouthfuls of pollen, and one node after another is touched with the mouth, although not held as is the "thumb" of the large appendage. Even the second row of microscopic nodes is licked and licked again. It was observed that the apex of the nodes is hyaline, and it may be slightly drawn in for a second, when it becomes somewhat flaccid. It suddenly becomes turgid and larger, and the larva touches it with the mouth. Sometimes three or four consecutive nodes are sucked, but it appears to be an effort to reach the apical ones.

The "thumb" is sucked most often, the large appendage is occasionally used as a prop or support, and it was often bent and twisted as the larvae struggled about on the ample communal pudding supplied by the author, but it does not appear to suffer any damage. The larvae ate, with apparent relish, a mixture of "royal jelly" from a queen-cell, and pollen taken from hive-bees, but none survived.

Contents of "nests" of *Exoneura angulata* Raym. in dry stems of *Hydrangea* taken at Essex Park, Dandenong, Victoria, October, 1948:—

No. of Stem	Length cm.	Adult Females	Larvae	Eggs	Puddings
1.	10	4	17	6	7
2.	5	2	4	7	0
3.	7.8	2	0	4	0
4.	11.5	7	14	4	9
5.	17.5	11	0	0	0
6.	17	4	18	6	22

A lone female was sheltering in a small cavity, and two females were in another. Two of the sticks exceeded 7mm. in diameter, and the gallery went down in a spiral, clockwise. No larva was more than 5 cm. from the base of the "nest", and none of the eggs was attached to the walls of the lumen; all were deposited criss-cross among the small larvae and puddings at the base. The puddings were bright-yellow in colour, and the grains oval; only one pudding in five contained triangular grains (*Leptospermum*). The *Hydrangea* was growing in a shaded position.

Early in November, 1948, at Dandenong, the author and his collector, Owen Dawson, found a long series of "nests" of *E. richardsoni* Raym. in dry stems of bramble and rose in the garden at Essex Park, the country home of W. R. Richardson, Esq., to whom the species is dedicated in appreciation of his hospitality and co-operation.

IN BLACKBERRY STEMS.

No. of Stem	Length cm.	Adult Females	Larvae	Eggs	Puddings
1.	2.5	1	Gallery under construction		
2.	4	1	—	—	—
3.	13	5	23	6	1
4.	10	4	18	Full-grown	
5.	12.5	4	20	10	—
		IN GARDEN ROSE STEMS.			
6.	15	6	16	6	—
7.	11	6	28	10	—
8.	10	1	1	—	—
9.	12.5	6	17	8	8
10.	10	2	3	4	—
11.	15	4	18	3	3
12.	12.5	4	5	—	—
13.	11	6	8	3	—
14.	10	4	—	—	—
15.	10	4	12	7	7
16.	12.5	2	—	—	—
17.	7.5	4	3	6	2
18.	10	2	5	3	2
19.	10	4	—	—	—
20.	10	2	8	4	—
21.	10	8	12	—	—
22.	4	4	12	2	—

This "nest" contained a mixed population, for there were two species, *E. angulata* and two *E. richardsoni*, and both appeared to be feeding the young.

A small black species, *E. rufitarsis* Raym., favoured the dry stems of garden *Dahlia*.

The author has studied many series of "nests" constructed and occupied by *Exoneura asimillima* Raym., and this species may be taken as typical of the group which deposits the eggs first, in a mass at the base of the chamber, and later provides a supply of rather dry mealy pollen in the interstices about the eggs.

All the larvae feed from the common store until they are well developed. After the appendages are absorbed, the larvae rest along the lumen of the tube, heads and tails touching. The supply of pollen is augmented daily, and the mass becomes more compact, with a larger proportion of honey, as the larvae grow. The youngest larvae are, of course, progressively fed with a secretion from the pharyngeal glands of the head.

The first "nests" in the stems of "Saw Sedge", *Gahnia tetragonocarpa,* and "Giant Rush", *Juncus pallidus,* were collected by Owen Dawson at the type locality, Grampians Range, Western Victoria, on 4th December, 1946.

Another long series was taken by this collector on 20th November, 1949, at Cranbourne, Southern Victoria. Twelve dry flower-stalks of "Grasstree", *Xanthorrhoea minor,* contained females and larvae in many stages, and the average number of progeny for one mother was six.

The pieces of stems were broken off 13 cm. in length, with a diameter of 8 mm.; the "bore" was 3-4 mm. in diameter and the longest measured 12 cm., the shortest about 3 cm., but these short ones were in course of construction; the average length of the completed bores was 5 cm. Two "nests" contained only very small larvae; one only eggs, no pollen; three females were present in three; two females in two; four of the "nests" contained only one female each. In no case were the larvae distributed along the lumen of the tube.

The original flower-stalks of the Grasstrees were about one metre tall, and dry, as they were grown in the previous year. The entrances were made where the pithy interior had been exposed on the end. In a few cases the entrances were through the woody side-wall, but these holes were the work of some other insect. The *Exoneurae* cannot penetrate hard fibrous structures.

In all the larger stems the entrance is contracted with a neat ring of wood-pulp.

The pollen-grains in these stems were triangular in shape, and had been collected from one plant, very probably *Melaleuca ericifolia*—or perhaps *M. squarosa*—which was abundant in an open gully among the sandhills, which are exploited commercially for the excellent sand. The aspect was N.W.-S.E.

No individual puddings were present in this series of "nests", but the oldest larvae were at the resting stage, and the appendages had been absorbed. Several of the older larvae from the Grampians had individual puddings, but as there is definitely some co-operation with females of other species, these may have been the progeny of an alien mother, or the habit may vary. Because the social habit is developing in the *Exoneurae,* the mothers of one species will feed secretion to the progeny of other females, and this complicates the investigations, and at times one is not entirely satisfied that all the larvae present in a populous nest are of one species.

Three or four species of females are exceedingly close in morphological structure, and difficult for the student to determine correctly. *E. asimillima* Raym. is very close to *E. holmesi* Raym., which has a light ferruginous-red abdomen and amber tegulae, with considerable long white hair on the "face", whereas *E. asimillima* has a dark blood-red abdomen, and the hair of the head is black. Over a series this is the larger, more robust bee, with black tegulae. All have red legs.

Another very close species is *E. obliterata* (Ckll.) Raym., but the larvae have only one long "finger" on the larval appendage, whereas *E. holmesi* larvae have three "fingers".

The "fingers" on the appendages of *E. asimillima* are small, and the larvae are clearly in the *E. hamulata* group.

The first appendage has three "fingers"; the second a short basal one; the third is simple. The other segments of the abdomen have short inconspicuous

nodes. The larval appendages are of the greatest value to the taxonomist, and in the absence of the larvae, the adults are often exceedingly difficult to separate.

At Essex Park large numbers of colonies of *E. richardsoni* Raym. were established in the dry twigs of a climbing rose that covered a garden arbour about sixty feet in length; consequently, the majority of the nesting sticks were in more or less permanent shade, for the arbour is ten or more feet in width.

Since the nests were seldom higher than the observer's head, the large aggregation of both bees and sticks could be studied very conveniently. Stems investigated during the first week in December, 1948, were very populous, for they contained males, many females, eggs, puddings and larvae, and the flight of field bees was heaviest at that period, even though most of them were in shade. Midsummer, then, sees the maximum in activity for this species, and this holds for all of the *Exoneurae* studied during this investigation.

By autumn the curve on the graph goes down steeply. On 6th March, 1949, numbers of sticks were investigated, and a large percentage contained only a lone female, with three or so eggs which had been deposited loosely at the base of the lumen, and among several pellets of rather dry yellowish pollen. These are the colony–founding females which had departed from the parent nest to find a suitable stick for a new nest. A small percentage of sticks housed a solitary male apparently sheltering.

In *E. richardsoni* the eggs were deposited "criss-cross", without order, at the base of the chamber, among the communal food, but when the growing larvae require individual attention they are disposed up the wall at regular intervals. This habit is in contrast to that of *E. roddiana* Raym., which deposits its eggs in a low spiral line on the wall, and it would be interesting to discover whether or not this latter habit holds goods for all the black species of *Exoneura*.

Up to seventeen pupae in advanced stages, together with a few callows, were present in many nests, and it was evident that these were the last of the second brood for the season. The colony-founding mothers represent the earliest individuals, and these pass through the winter nursing their progeny which form the first brood of the succeeding spring. The activity, then, reaches the minimum during the winter months of May, June, July, but does not cease entirely at any stage.

The larva of *E. lawsoni* Raym. has two "fingers" on the "arm", and there is a basal "thumb", but the adults are black, and approach *E. rufitarsis*. In addition, *lawsoni* has six long processes on the apical ventral segments of the abdomen, *E. hamulata* Ckll., a larger red-bodied species, has eight lateral "arms", with three "fingers" on the first and second pair; one on the third pair, and a short nodule on the fourth pair.

Another species, *E. sub-baculifera* Raym., has a prominent "teat" on the vertex of the head, and Norman Rodd suggested that the adults might obtain a secretion from these protuberances. Wheeler has pointed out that this actually occurs in certain ants. The larvae of *E. baculifera* Ckll. have only a very small cephalic node or "teat", and only rudimentary lateral appendages.

Rodd suggested that the unique teat-like cephalic node on the larvae of *E. sub-baculifera* Raym. may be an exudatorium, such as is present on certain ant larvae, i.e., *Pachysima latifrons*, the adults of which obtain an exudate, a lipoid, from the appendages; ant-larvae are known to exude fatty substances. Rodd suggested that male *Exoneurae* may obtain such an exudate, hence their continued association with the "nest".

Rodd observed the larvae of *E. roddiana,* each with a ball of pollen held between what Friese terms the pseudopodia, and Wheeler himself prefers this name. The latter author says that the pseudopodia of *Allodape ceratinoides* hold the pollen-ball to the buccal parts. Holmgren thought that the several castes in ants may be due to "exudate hunger", i.e., food castration.

It was observed by the present author that the "arms" on larvae of *E. rufitarsis* Raym. did appear to be larger on some occasions, and he saw a female adult lick one. On another occasion he observed a nursing female feed secretion to an adult male. In any case, the larvae are fed probably for 20 days with the secretion, and after that pollen may be observed in the mesenteron, but never in the tightly-packed manner of *Halictus* and many other genera.

The individual pollen-ball is supplied to the larvae at about 50 or so days after hatching, and the yellowish (greenish on Pollinite) mass is then visible in the mesenteron. This is much slower than what obtains in the bee-hive, where the larvae are fed for about eight days.

It will be seen that while it is extremely difficult to separate the many field bees closely resembling *E. angophorae,* yet the larvae are very different, and it is unwise in many cases to write specific descriptions of new species in the absence of the larval forms. There are so many very cirtical species.

The appendages reach their full development just about the time that the larvae are fully fed, but as metamorphosis is approached, the appendages are gradually absorbed, and then the taxonomist will be misled by their absence. The largest larvae measured over 3,000 microns in length.

In the "Victorian Naturalist", April, 1946, the author suggested that the "arms" could be used for clinging to the few silken threads on the wall of the tube, but he has now definitely established that the larvae adhere to the wall by the long tapering anal end, which is unique in bees.

The author had a number of "nests" of *E. rufitarsis* under continuous observation, and the females were observed to apply the mouth to the head of the larvae, and it was possible to see the transfer of a clear liquid, probably food. The "champing" and "mouthing" of the larvae indicate that they are requiring food. After the females attend to them the "mouthing" action ceases, and the larvae lapse into a resting-phase. By transmitted light it was possible to observe the processes of digestion in the mesenteron, which contained a pale-yellowish liquid. The contents "boiled" up in rhythmical ebullitions, like a miniature geyser, and then fell back again, and after each eruption the liquid became paler. Minute bubbles appeared to rise from the epithelial cells and mingle with the food. This led the author to postulate that enzymes were being released and incorporated in the mass. The author was able to study under a lens the feeding of a secretion, by the several sisters, to the larvae in a tube. The female bends the slender glossa back under the head, and opening wide her mandibles, takes the tip of the larval head right in between her open jaws, which do not move.

A clear liquid is then exuded on to the larval mouth for a second or two. This is undoubtedly a copious secretion of the pharyngeal glands, and the larva injests it with a conspicuous "mouthing" of the "lips". Another adult female will sometimes "kiss" the larva after its feeding as though it were wiping the soiled mouth of the infant. There is evidence of continued care and gentle attention by all the mothers, but the glossa plays almost no part in the feeding, for the secretion appears to flow from the salivarium. (See "Behaviour of the Individual", below.)

The author has not observed a store of food in any of the many "nests" investigated by him, and to test whether or not the larvae could or would eat a pollen substitute he provided hungry larvae with pollen taken from the cells of the hive, and also a synthetic pollen which he had evolved, and the oldest larvae made a meal from both. Of course no adults were present at this experiment.

The adult bees, too, repaired to another pollen-mass provided by the author. and opening the mandibles to their widest extent, plunged them into the soft batter of honey and pollen; the mandibles do not appear to move, yet the batter could be seen moving into the mouth as though it were being drawn in by suction. The long slender glossa is bent back under the head during the meal, and does not appear to play any part in the action.

It is definitely established that there is no food stored in the communal chamber; that the pharyngeal glands of the females are well developed, and that a secretion is fed to the larvae; a certain amount of pollen is incorporated later; and finally each larva receives its individual ball; and that progressive feeding is the rule of *Exoneura.*

The author had difficulty in bringing the larvae through metamorphosis, probably because the presence of the adult nurses is essential for their proper development; consequently, he determined the time required for the transformation to be approximately 152 days.

It was observed that ever and anon the adults apply the "mouth" to the cephalic pole of the egg, and stroke it downwards two or three times with the fore-legs—it appears to be a cleasing with the tarsal brushes. The action is repeated on the larvae. It is a remarkable fact that only a few of the many spring "nests" studied contained a pupa, although there were numbers of well-developed larvae present. Many pupae are present in mid-summer and autumn.

That the larvae are able to survive long fasts is demonstrated by the following experience of the author. On the 8th June, 1946, he visited a sandstone gully at Lane Cove, Sydney, and collected several "nests" of *E. roddiana* Raym. in *Acacia* twigs, and these were packed in a tight tin container. The author returned to Sandringham, Victoria, after a month of travel on 8th July, 1946, but a chain of circumstances prevented him from examining the "nests" until 90 days later. When the package was opened, the author was astonished to discover that the larvae and adults were still very much alive. All were positively without food for that period. Rodd, too, observed that the bees are capable of surviving long periods of abstention.

There are no distinctive characters on the pupa; no abdominal nodes and spines as in *Halictus, Parasphecodes* and *Nomia,* for it has the typical form of the social bees' babies. There are two or three spines on the legs, i.e., strigilis and calcariae.

It was of interest to discover that larvae, feeding on a pollen-ball supplied by the author, showed a blackish mass, at the caudal end, about 24th October, and in a day or two a cylindrical pellet of excreta was voided. The junction of the proctodeum and the mesenteron must occur much earlier than in the hive-bee, and while the larval feeding is drawing to a close.

In the unnatural conditions inseparable from the author's experiments, 152 days were required for the development of the bees from egg to imagine, and it might be argued that growth had been hampered by unsuitable food, but an examination of the "nests" on the tea-tree branch on 1st November revealed similar conditions. These could be relied on because the date of the installation of the mothers in the stems was known and, thereafter, they had been left to their own resources. The feeding period of 30 days with secretion and 40 days with pollen is certainly very remarkable if that be the normal time.

Behaviour of the Individual.

In winter, from the middle of July, the bees are sluggish, but there were many eggs, and a few young larvae in colonies of *E. roddiana* and *E. concinnula,* and *E. rufitarsis* even at that early date. Surprisingly, the bees do not, like all other wild-bees, dash out to the light when their tubes are opened and attached to the branch, but for safety, it is better to open the sticks at night, leaving the bees to emerge in their own time on the following morning.

Like all other bees, both hive and wild, the actual doorway is examined first with extreme care. The bees walk round and round the periphery, evidently memorising the details, not venturing far on the initial excursions, and returning by the same path.

The earliest appearance of females of *E. richardsoni* from the experimental tubes was on 1st September, 1949; August was distinguished by many warm

days, with a subnormal precipitation. When September opened, the temperatures registered max. 22.6 deg. C., min. 5.5 deg. C., and at 11.30 a.m. two energetic females emerged from one stem for a short flight of less than a metre. They were followed soon after by three females from other stems, but all returned after re-orienting the sites of the nests; three others departed to harvest in the field. A male was observed to issue from one stem and depart. He did not return until 35 minutes later. The bees seldom flew at lower temperatures.

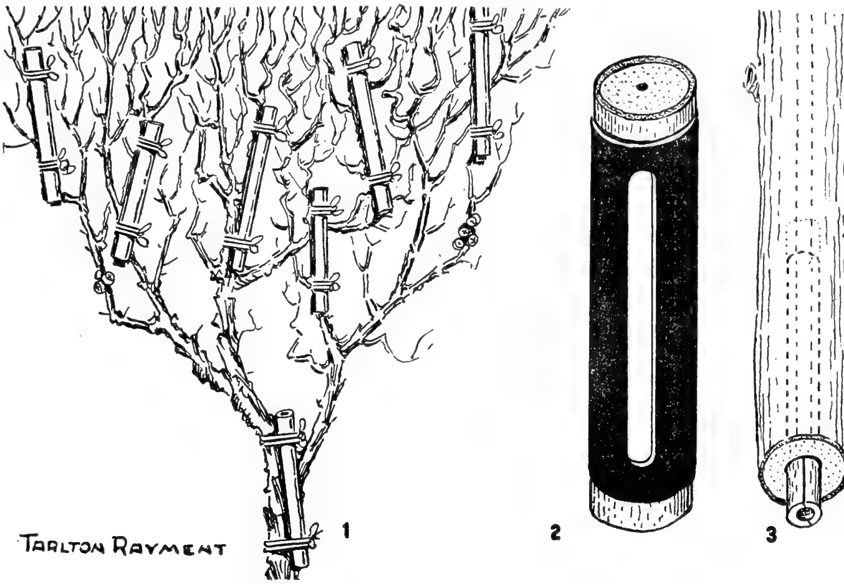

Fig. 2.

1. Dry branch with short lengths of Hydrangea stems tied on at convenient levels to attract the reed-bees **Exoneura rufitarsis** Raym.
2. Black sleeve over a stick, with a clear "window" for observation of the larvae.
3. A split stem with a nest is inserted at the base of a larger stem.

They descend into the tube and re-emerge many times to sit in the warmth, preening themselves, exercising their wings and brushing the body. The first flight is merely of 30 or so centimetres, made with the head facing the doorway. Longer and longer flights are made successively, as the "map of the country" is plotted in the insect's brain. These experiments in orientation are repeated so often that the observer's patience is sorely tested. Unlike other wild-bees, the males of which never return to the "nest", and therefore have no need to memorise the way home, the male *Exoneurae* never desert the family; consequently, they are as meticulous as the females in orientating the site of the "nest". (Refer to "Larval Food".) The bees are certainly not nervous, suspicious or aggressive, for the observer may, with a very fine brush, actually guide the sunning bees back into the tube without causing them to take wing. They do not resent the author's close presence, and betray no interest whatever in the movements of the lens.

Should any bees emerge suddenly before they have orientated their new homesite, they will be lost, for then they cannot return. When they appear of their own volition they will re-orient themselves.

The bees do not take wing immediately on emerging, but only after a long survey of the sunny surroundings do they fly on short courses, zig-zagging con-

stantly as they advance and retreat, with the head always directed to the aperture of the gallery. The pattern of the flight is very different from that of *Halictus*, which, having no obstacle in the near vicinity of its individual shaft, performs a number of circular sweeps.

There is no doubt that the close proximity of several galleries amid a tangle of other dried twigs is responsible for the reed-bees' care in orientating the "nest" accurately. The pattern of bees' memorising flights is due to the nature of the environment. Such flights take place only during the warmest hours, between 11 a.m. and 3 p.m.

The cavity of the tube is frequently blocked by the flattened apical tergites of the abdomen. Males have been observed to hover, alight and enter the tube, and immediately block the entrance as described. The action is common to both sexes, and has been observed also in very different earth-digging halictine bees.

In the half-cylinders the bees have no necessity to roll over in a ball when they reverse, but the action must be instinctive, for very frequently they turn in this surprising manner. The "ball" is, of course, formed by tucking in the head and the abdomen until the "body" is of the same diameter as the tube—it is a case of "heels over head", rapidly and very neatly performed. The pithy debris near the door is pushed out by the hind legs and the tip of the abdomen, in the form of very fine shavings, but the boring is a slow process, although the material is both soft and light.

In the tubes, the females of *E. rufitarsis* Raym. frequently dropped a globule of a secretion on the interior walls.

It was early evident that six females in a tube secreted far more food than could be consumed by the nine larvae; consequently, the surplus was exuded on to the wall. The author succeeded in getting a globule or two placed on a glass slip, when it was seen to be microscopically grandular, with a slight milky opacity, and giving an acid reaction. Every now and then two females will approach and "kiss" each other—that is, the mandibles do not open, but the maxillary and labial palpi of both bees are extruded and moved about rapidly as they "caress" each other. On several occasions it seemed that some liquid passed from one adult to another. The long glossa was bent back under the head and did not function. The author would say that some secretion is available, for he observed that after a female had fed a larva, another female would come along and sip a trifle from about the mandibles of both the adult and the baby as though "wiping its mouth".

The bees have frequent "rest" periods, when they stand immobilised for a minute or two; then the abdomen will pulsate rapidly for a little longer, during which time it can be seen that the ivory-coloured "thread" of the oesophagus, nerves, etc., at the foramen is also pulsating in rhythm. There is, too, a short phase when the thorax is vibrated vertically very rapidly. The bee then resumes other activities. If one sister unexpectedly encounters another, the mandibles are held wide open, in a threatening gesture, but after a "kiss" both go on their way. The bees are exceedingly "light on their feet", for while they often walk over the eggs and the larvae, yet they never inflict the slightest damage to either.

In the galls observed by Chadwick the adult females carried the larvae from place to place, and this action was observed by the author in several of the "nests" investigated by him; the transportation of the larvae may have been due to panic when the adults were suddenly exposed to light. That observer also saw the females of *E. concinnula* closing the entrance with the subapical segments of the abdomen.

A deal of time is devoted to cleaning the body. The antennae are constantly combed and brushed by the anterior legs, as is the long glossa, and the head and eyes. The median legs are turned up over the thorax, which is

kept highly polished, since there is little hair; the median pair also clean the upper surface of the wings, and assist in the toilet of the hind legs, the wings are pressed flat under the abdomen, and the under surface is then vigorously brushed. The gaster is cleaned by the posterior legs, and the pair are constantly being brushed together. Every now and then the wings are given a sudden flick or two. Considerable time and energy is expended on the toilet.

The introduction of a strange male to five females in a tube under observation produced no evident reactions, the bees showing no interest whatever in the stranger, but it should be remembered that the conditions were unnatural, and scent did not appear to have any significance.

A few excessively tenuous threads are "licked" on the walls of the tube, and the tip of the glossa travels over the surface without haste. Every now and then the head-capsule is rolled rapidly from side to side as the front legs curve round the genae and the compound eyes. The whole action suggests that of a man bringing his bowed arms alternately up over his head quickly. It cannot be a mere matter of cleansing, for the polished head is immaculate. The author suggests that this remarkable action excites the glands of the head. (See fig. 4, pl. xxvii.)

These two organs in the *Hymenoptera* are the cause of some confusion to certain authors, who refer to the secretions of both glands as saliva. Indeed, one says the eggs of certain ants are stuck together with saliva, but probably the mucous glands in the apical segments of the female abdomen are the source of the "egg-glue".

Enemies and Parasites.

Like all other bees, the *Exoneurae* have several enemies, endoparasites and ectoparasites are present, and of the former, minute chalcid wasps in the Family Encyrtidae are the more numerous.

Norman Rodd, Lane Cove, sent to the author the dry shell of a red reed-bee, probably *Exoneura angophorae* Ckll., which contained a large number of hymenopterous larvae disposed in close symmetrical rows. The body of the host had been reduced to the merest dry skin, for the whole of the interior had been consumed by the horde of parasites. These were reared to maturity, and the adult wasps proved to be a new species, for which the author proposed the name *Aphycus asperithorax* Rayment, 1949. The tiny wasps could easily enter the plant-stems in which the reed-bees "nest" and insert an egg in every larva, for there are no protective obstacles, such as woody cell-divisions, in the communal chambers, and although the aperture of the bee's tube is small, sometimes less than 3 mm., yet these parasites are much smaller.

However, the chalcid parasites are also successful even when there are several cell-divisions in the plant-stem, for the author received such a one from Owen Dawson, Clyde, Victoria. This collector had broken off a dry stem from a plant of *Viminaria denudata,* thinking that it contained a nest of *Exoneura rufitarsis* Raym., but on splitting it, discovered several cell-divisions, with a larva occupying each chamber. Careful investigation showed that a tiny entrance had been drilled through the wall, a condition never present in *Exoneura* "nests". This one proved to be the work of *Hylaeus nigrojugata* Raym., and it was quite typical, for it contained several cells of impalpable silvery tissue, each divided by a hard wad of dark red pollen residue and stercoral debris. It was evident that in no case had the plugs been perforated, and the parasitic female wasp must have entered each chamber successively as it was completed, for all the cells were constructed contiguously along the tube. This stem was collected on 13th July, 1946; that is, in winter, and it was observed that, at that early date, each bee-larva was infested with numbers of still more minute larvae. Metamorphic changes became evident on the 20th September, and most had reached the pupa stage by the 21st September. They were completely black by October 15th, and emerged as imagines about 24th October. An average of 22 was

obtained from each small bee-larva, but they were not disposed in such exceedingly orderly rows as those of *Aphycus*.

The progeny of the reed-bees is not more vulnerable to attack because of the utter absence of such barriers as cell-divisions, for "nests" containing several of these obstacles suffer equally heavy infestation.

The excessive numbers of parasites present in each bee-larva would, at first glance, connote a similarly large deposition of wasp eggs, but the minute size of the wasp—a millimetre—presents certain difficulties for this concept, since the ovaries are not excessively prolific.

It appears that only one egg is deposited by the parasite in each bee-larva, but the egg is capable of a remarkable division, so that dozens of young parasites result from the one ovum—"polyembryony". This phenomenon is not limited to the Encyrtidae, for it occurs in the higher animals, and even in man himself, as when a woman bears identical twins from one ovum.

The author has recovered a partly-digested Acarid mite from the pollen residues in a larva of *Exoneura,* and also what appeared to be a triungulin. It would appear that if a triungulin of *Stylops* enter by the alimentary canal, and reach the mesenteron, then it might leave that organ prior to or at its junction with the proctodeum, and the parasite's ultimate position, between the third and fourth tergites of the imagine, is reasonably explained. However, this is a mere speculation. [2]

The bees are remarkably free from Acarine mites, [3] but one was present in a "nest" in a gall collected in Sydney. The reason for this freedom from mites is obscure, for *Lestis,* [4] a large carpenter-bee, living in almost parallel conditions, sometimes has several score of mites on the body. Spiders constructing their webs on shrubs occupied by the bees secure an odd victim, but the captures by this enemy are few, and have little incidence on the success of the species. The small size of the bees, and their rapid flight, apparently bestowed a certain immunity from attacks by birds and entomophagous insects, for in the colonies established by the author at his home only a rare reed-bee fails to return to the "nest" during the working season.

Ants range over most plants, and most often encounter the galleries of the *Exoneurae,* but as there are usually several female bees present in each "nest", ants secure few victims. The size of the aperture seldom exceeds 3 mm. in diameter, and often is less, so that only the smaller black ants can effect an easy entrance. *Iridomyrmex rufoniger* often investigates, but is rarely successful.

Notes on Anatomy and Physiology.

The glossa is exceedingly long for such small insects, and, as in all bees, covered with a mass of setae disposed in a characteristic pattern. In *Apis,* the hive-bee, and in *Exoneura* the setae are acute, but in *Asaropoda* they are spatulate; in *Paracolletes* they are still broader, in *Anthophora* they are leaf-like, and doubtless serve as spreaders of the saliva forming the colloidal membrane. It will be remembered that all animals lick with the dorsal surface of the tongue, and when bees turn the tip of the glossa under and backwards, the setae are then in the proper position for spreading.

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2. In the few cases investigated by the author, the abdominal organs of bees parasitised by a stylops did not appear to have suffered any structural damage, and the observer is therefore tempted to formulate a theory. An exceedingly large percentage of bees, **Euryglossimorpha nigra** Sm., from Mt. Canoblas, New South Wales, was parasitised by a stylops, and on one bee the third and fourth tergites had become permanently deformed, but the stylops had disappeared.

3. This Tyroglyphid mite was mounted and submitted to Mr. H. Womersley, South Australian Museum, and he kindly determined it as **Tyrofagus tenuiclavus** Zachvatkin, 1941. It is closely allied to the flour and cheese mites of Europe, and this is a new record for Australia.

4. Deutonymphs of **Sennertis bifilis** Canest., and in the wandering stage they are often present on carpenter bees. I am indebted to Mr. Womersley for both determinations.

There are four segments in the labial palpus, the basal pair being exceedingly long; the maxillary palpus has five segments, although in the generic diagnosis in "a Cluster of Bees" six segments are given in error. The salivarium, near the base of the paraglossae, plays an important function in the physiology of the reed-bees, and the author observed that the secretion of the pharyngeal glands seldom flows down the pseudo-tube of the glossa, but wells up out of the salivarium. When the female is subjected to an anaesthetic, such as ether, a globule will sometimes appear at the salivarium, but generally it will be absorbed before it has time to flow down the glossa. This can be observed quite clearly when the whole of the mouthparts are extruded.

McIndoo (1916) says: "It is strange that both liquids can travel in opposite directions along the same route by no force other than capillarity". He believed that both honey and saliva flowed side by side in the glossal tube. Snodgrass (1925) says this explanation is "too strange, and Nature did not devise the plan". The latter author says he "has no evidence that food liquids ever go up the ventral channel of the glossa". My experiments demonstrated conclusively that in *Exoneura* at least the glandular "pap" does not pass along the glossal tube during the feeding of the larvae, for that organ is folded back clear under the head and, in that position, can have no function as a channel. The secretion of the post-cerebral salivary glands, however, appears to flow along the glossal tube, but this is difficult to observe; only the tip of the glossa is used for draping the wall. The latter author observed a secretion welling out as a clear liquid which swells the glossal channel in honey-bees under an anaesthetic. Snodgrass says this occurs after the insects have been fed on cane sugar for some time. The globule on the salivarium may be seen in wild bees which have never known sugar; indeed, it is present in individuals which have never eaten. In *Exoneura* it is definitely the salivarium which is applied to the mouth of the larva.

The pharyngeal glands of the head are well developed, and resemble a grape-like cluster of pearls when the nursing bees are secreting copiously.

The general design of the alimentary canal approximates that of the honey-bee; a narrow tube passes as the oesophagus through the head and thorax, enlarging into a clear thin pear-shaped honey-sac, again constructed and closed by the minute proventricular valve, greatly expanded as the cylindrical corrugated ventriculus, or true stomach, constricted yet again as the small intestine, and again greatly distended as the rectum or large bowel, and finally constricted to form the anus at the apical segment of the abdomen.

As in the honey-bee, *Apis*, the epithelium of the rectum in *E. rufitarsis* is a thin cellular layer against the cuticular intima of the outer surface. On the anterior half are six rectal glands, circular in form, and clear, resembling ocelli. They are paler and appear to be semispherical, and covered with a microscopic, close network of tracheal tubes.

Snodgrass says that each of the glands in the honey-bees is a "hollow cylindrical tube, with a thick inner wall and a thinner outer wall. When the rectum is distended the glands bulge on the outer surface as six opaque ridges, but when empty the glands sink into the walls and protrude into the lumen". The glands of *Exoneura* appear to have a similar structure.

The rectum of the *Exoneura* examined, males and females, contained a few shells of pollen, but was not unduly distended, although it was winter. The author is unable to say what would be the appearance of the glands if the rectum were excessively distended as sometimes occurs when honey-bees are confined to the hive for long periods by stormy weather.

Trappmann (1923) thought that a secretion from the glands is discharged into the rectum, and Pavlovsky and Zarin (1922) suggested that the glands are a source of catalase, and also bring about oxidising processes. However, the real function of the glands has not yet been satisfactorily explained, but as they are excessively large in the pollen-eating Halictine bees, and small in the species feeding

the secretion to the young, it would appear that Pavlosky and Zarin's explanatiton is probably correct.

The proventricular valve in *Exoneura* is similar in form to that of *Apis,* the hive-bee. It is quadrangular rather than spherical, and apparently functions in the same manner, i.e., regulating the supply of nectar passing through from the pear-shaped thin membranous honey-sac to the corrugated ventriculus, or true stomach, where it becomes available for the sustenance of the bee, the sac being merely a vessel for carrying the sweet.

In certain hive-bees received by the author from Inverell, New South Wales, and which were dying on the ground under white-box trees (*Eucalyptus albens*), it was found that the proventricular valve was much enlarged, and so congested with pollen-grains that it could no longer function, and the bees succumbed. An exceedingly large yeast was present in numbers in the rectum, but whether or not this had any incidence on the mortality could not be investigated.

There are a few malpighian tubules, about twelve, whereas the honey-bee has perhaps a hundred of them. The tubules undoubtedly function as kidneys, throwing off urates, phosphates and calcium carbonate, and a milky drop or two of these is voided on or before the first flight. It is significant that in the very different genus, *Halictus,* the tubules of the newly-emerged imagines are very yellow with waste products, but these bees are confined to a diet mainly of pollen. The tubules of *Exoneura* are much paler.

The fat body is conspicuous in the imagines, but oenocytes are not prominent in the older larvae, although they are numerous in other genera feeding mainly on a honey and pollen diet, with a minimum of glandular secretion.

The sting of the female is well developed, but incapable of penetrating human epidermis, for the bees are very small.

The genitalia of the males is distinctive, with two fringes of stout spines, and are thus quite unlike the genitalia of other bees.

The author was more than surprised to find that the anterior legs of *Exoneura rufitarsis* Raym. (5 mm. in length) were identical in size and proportion with those of *Halictus erythrurus dimorphus* Raym. (5 mm. in length), although the latter is in a very different family of earth-digging bees and, therefore, far lower on the evolutionary ladder than the reed-bees. Such a close likeness is more than co-incidental; it demonstrates the common inheritance of the bees.

Summary.

The reed-bees are widely distributed along the eastern and southern littoral of Australia; from Queensland to Western Australia. All the species are small, 3-6 mm. and even less, in length, and none makes any attack on the observer, for they are neither excitable nor aggressive, but docile and attractive.

The "nests" are almost invariably in stems or reeds with a soft pithy core, and there are no cell-divisions, only one communal chamber. The bees have very little constructive ability.

Certain species attach the eggs in a row to the wall; others deposit them criss-cross, loose, at the base of the lumen; some species develop the larvae on a communal pudding. The incubation of the egg takes up to 20 days, and complete development of the larva over four months.

The larvae have unique "arms" and "fingers", and for 30 days or so are fed by the several nurses with a copious secretion of the pharyngeal glands of the head. Later, each larva receives its own individual pudding of pollen, which is held to the buccal parts on the ventral surface.

The imagines and larvae are capable of surviving lengthy periods of abstention from food—more than 90 days, but the experiment was not pressed to the extreme limit.

The larval appendages provide the most reliable specific characters, and, in the absence of the larvae, it is unwise to describe any bee as new, for many species are very critical.

That the pseudopodia function as exudatoria was determined conclusively. The appendages are absorbed on the approach of metamorphosis, and the faeces are ejected while the larva is still feeding, demonstrating that the junction of the proctodeum and mesenteron is effected at an earlier stage than in other bees.

There are no castes, but several sisters remain together in one stem, and attend to all the duties; males, too, are usually present, therefore, the genus must be regarded as a social one, although of a primitive kind.

The experiments with *E. rufitarsis* and *E. richardsoni* demonstrated that not more than two broods, a spring and an autumn one of males and females, are reared each season. The adults have a long life compared with the simple wild-bees, for they live for more than twelve months, and are present in the home when the young are finally developed as imagines. There is, therefore, some support for Prof. W. M. Wheeler's postulation that longevity of the parents is a factor in the evolution of the social state.

The three types of larval development in *Exoneura* have parallels in the South African genus *Allodape*.

There is some exchange of glandular food from one adult to another (Honey-bee workers normally pass honey from one to another, and secretion to the queen).

The rectal glands are larger on genera feeding on a more primitive pudding of pollen and honey with a modicum of secretion.

The bees visit many botanical species in entirely different families.

The dates given in the calendar below are, of course, approximate only, for although several hundreds of larvae were kept under close observation, it was impossible to discern the actual beginning of the change from one phase to another. Moreover, the larvae were subjected to various experiments, and often it was not possible to determine conclusively the incidence of these on the ultimate development of the insect. The mother bees cannot be held indefinitely in the observatory tubes, and the absence of the females for long periods, in the artificial conditions of the laboratory, doubtless militate against the normal development of the larvae. Males are the first to succumb to imprisonment.

Calendar of Development.

Female *Exoneura richardsoni* Raym.

Incubation 18-20 days.	7 July, 1948:	A series of females with eggs in plant stem.
	15 „ „	A granular opacity appears in middle of egg.
	20 „ „	Opaque area enlarged, but poles translucent.
	26 „ „	Segmentation visible; eggs hatched, secretion being fed.
Copious secretion 14-20 days.	27 „ „	Females feeding larvae copiously with secretion.
	30 „ „	Progessive feeding with secretion continued.
	5 Aug. „	Nodes developing on larvae.
	10 „ „	Copious feeding maintained; nodes larger.
	15 „ „	Nodes developed into defined "arms".
Pollen added 10 days	16 „ „	Mothers adding some pollen to secretion.
	20 „ „	Orange-coloured pollen visible in mesenteron.
	25 „ „	Pollen percentage increasing in food, but secretion decreasing.

Larvae eating pollen-ball 37 days.	26 „	„	Pollen-ball given to larva on ventral surface.
	30 „	„	Larvae consuming pollen taken from hive-bees.
	5 Sept.	„	Larvae consuming synthetic pollen; greenish colour in mesenteron.
	10 „	„	Larvae receive "Royal Pap" mixed with pollen from hive-bees.
	15 „	„	Mesenteron appears to contain much pollen.
	20 „	„	Pellet of excreta aggregating at caudal pole of larva.
	25 „	„	Larvae still feeding. First pellet excreted.
	1 Oct.	„	Desultory feeding by larvae. Second pellet excreted.
Resting phase 30 days.	5 „	„	Feeding ceases; third pellet excreted; larvae writhe on exposure.
	10 „	„	Larvae apparently resting; "arms" almost absorbed.
	20 „	„	Resting phase continues, no movement.
	31 „	„	Pellicle somewhat flaccid, pupa revealed.
Pupal phase 35 days.	1 Nov.	„	Pellicle still attached at caudal pole.
	10 „	„	All eyes faintly pink.
	20 „	„	Eyes dark-pink, lead-colour on head and thorax.
	30 „	„	Eyes, head and thorax all deepest royal-blue colour.
	2 Dec.	„	Eyes, head, thorax deepest blue-black; abdomen pale-amber; all appendages still white; wings dark-grey.
	4 „	„	Only tibiae, tarsi and mouthparts white; coxae, trochanters, femora and antennae blue-black; base of abdomen with dark cloud.
	5 „	„	Imagine fully developed, but wings milky white; walking with vigour; adult colouring now complete.

Total period 152 days approx.

The maximum for activity is reached in mid-summer, and during the second week in January the colonies are very populous, with many males present in the stems, and it appears that copulation occurs there; eggs, puddings, larvae, pupae, imagines, are all present at that period.

Acknowledgments.

The author is indebted to the courtesy of Dr. A. J. Nicholson, Chief of the Entomological Division, C.S.I.R.O., Canberra, for the serial sections used in the studies of the histology of the larval appendages of *Exoneura richardsoni*, sp. nov.

EXPLANATION OF PLATE xxvii.

1. Adult female, *Exoneura rufitarsis* Raym., "grooming" and feeding a young larva with the secretion; note the glossa folded back under the head.
2. Two adult females during the "kissing" action.
3. One female "wiping the mouth" of a nurse-bee after she had fed a larva.
4. During the "draping" of the walls, the eyes and genae are stroked rapidly with the forelegs alternately as the head rolls from side to side.
5. Adult females turn "heels over head" as they reverse in the lumen of the stem.
6. Portion of the alimentary canal, showing rectum and circular rectal glands (marked by the arrow), malpighian tubules, and portion of ventriculus.
7. Rectal gland more highly magnified to show the close network of trachea.
8. Mandible of female *Exoneurae* is bidentate.
9. Mandible of the male is simple.
10. Genitalia of male *E. perpensa* Ckll.
11. Genitalia of male *E. rufitarsis* Raym. at the same magnification. Note the unique spines.
12. Anterior wing; note the absence of the second recurrent nervure; this character is responsible for the generic name.
13. Anterior wing with five hamuli.
14. Seventh tergite of the male.
15. Myrtaceous pollen-grains removed from the ventriculus of a male.
16. Labrum of the female.

EXPLANATION OF PLATE xxviii.

1. Egg of *Exoneura rufitarsis* Raym.; note the hyaline caudal pole.
2. Young larva before the lateral appendages appear.
3. Larva soon after the appearance of the appendages.
4. The appendages are fully developed at forty days.
5. As metamorphosis approaches the appendages are gradually absorbed.
6. At one phase the appendages become distended.
7. The pupa presents no distinctive characters apart from the long spines of the tibiae. (All the preceding figs. at same magnification.)
8. Oblique ventral view showing the last phase of the invagination of the apical segments of the abdomen.
9. Larva of *E. sub-baculifera* Raym.; note the prominent cephalic protuberance and numerous abdominal processes.
10. Oblique ventral view of apical processes of *E. richardsoni* Raym.
11. A. B. C. D. First, second, third, fourth lateral appendages of *Exoneura hamulata* Ckll.
12. The pharyngeal glands are well developed in the *Exoneurae*.

EXPLANATION OF PLATE xxix.

1. Front of head-capsule of female *Exoneura rufitarsis* Raym.
2. Front of head-capsule of male; note the excavated areas about the bases of the scapes.
3. Mouthparts showing the slender glossa and maxillary and labial palpi. The position of the salivarium is marked by an arrow in this and the next figure. Pressure from the cover-glass causes deformity of the parts.
4. Head-capsule of female pupa showing the development of the mouthparts.
5. Portion of glossa highly magnified to show the arrangement of the acute setae.
6. Margin of galea highly magnified.
7. Anterior leg of male.
8. Hooklet of the fifth tarsus of the male.
9. Flagellum of the female.
10. Strigilis of the male.
11. Portion of the opposing comb of the antenna-cleaner.
12. Hind calcar of male.
13. Median leg of male.
14. Posterior leg of female.
15. Two of the forked hairs from the leg.
16. Oblique ventral view showing the invagination of the apical segments of the abdomen.
17. Pharyngeal plate of the female.
18. Ducts of the pharyngeal glands more highly magnified.
19. The delicate sculpturing of the mesothorax.

EXPLANATION OF PLATE xxx.

Clypeal Markings on Species of *Exoneura*.

1- 2. Male and female *E. obliterata* Ckll.
3- 4. *E. lawsoni* Raym.
5- 6. *E. rufitarsis* Raym.
7- 8. *E. richardsoni* Raym.
9-10. *E. asimillima* Raym.; lower portion is suffused in female.
11-12. *E. holmesi* Raym.; lower portion is suffused in male.
13-14. *E. hamulata* Ckll.
15-16. *E. montana* Raym.
17-18. *E. abstrusa* Ckll.
19. Male *E. ziegleri* Raym.
20. Female *E. angophorella* Raym; median portion is suffused.
21-22. Male and female *E. perpensa* Ckll.
23. Female *E. asimillima* Raym.
24. Female *E. albolineata* Ckll.

25-26. Male and female *E. roddiana* Raym.
27. The female *E. rufa* Raym. has a suffused area.
28. The female *E. florentiae* Raym. has the clypeus suffused.
29. Male *E. bicincta* Raym.
30. Male *E. xanthoclypeata* Raym.

EXPLANATION OF PLATE xxxi.

1. Adult wasp *Aphycus asperithorax* Raym.
2. Antenna of the wasp.
3. One of the segments of the flagellum more highly magnified to show the large longitudinal pore-organs.
4. Sculpture of the mesothorax and scutellum.
5. Fifth tarsal segment and claws of the wasp.
6. Expanded basitarsus of male bee *Exoneura richardsoni* Raym.
7. Tyroglyphid mite *Tyrofagus tenuiclavus* Zachvatkin, taken from a gall.
8. Apical segment of tarsus of mite.
9. Deutonymph of *Sennertis bifilis* Canest.
10. Gall-forming beetle *Ethon affine* Laporte & Gory .
11. Striae and hair of thorax of beetle.
12-13. Lateral processes of larva of *E. richardsoni* Raym.
14. Tarsal segments of anterior leg of beetle.
15. The entrance to the "nesting" stick is often contracted with an iris of pithy substance.
16. Front of head-capsule of female bee, *E. angulata* Raym.
17. Front of head-capsule of male bee, *E. richardsoni* Raym.
18. Gall formed by the buprestid beetle on stem of *Pultenaea stipularis*.
19. Section of the gall showing cavity and exit used later by the bee.

EXPLANATION OF PLATE xxxii.

1. Transverse section of young larva of *Exoneura richardsoni,* sp. nov. magnified 100 X. The section is cut apicad of the appendages.
2. Transverse section of an older larva, with the lateral appendages partially absorbed.
3. Transverse section of a larva near the base of the appendages. The wing-muscles are in an early stage of development.
4. Portion of the cell-structure immediately beneath the wing-muscles magnified 600 X.
5. One of the cells more highly magnified.
6. Transverse section of "thumb" of appendage showing the lumen.
7. Longitudinal section of apical portion of the appendage showing cells and lumen.
8. Three of the secreting cells of the lumen more highly magnified.
9. Oblique section at base of the appendage.
10. Cells at base more highly magnified.
11. Transverse section of appendage showing cells and lumen.
12. Transverse section of the larval mesenteron.
13. Epithelial cells of the ventriculus do not differ from those of the hive-bee *Apis*.
14. Sensory hair of the body-wall showing the connection with the cell beneath the cuticula.
15. Oblique section at base of one of the two frontal processes of the head.

The serial sections were prepared in the laboratory of the Entomological Division, C.S.I.R.O., Canberra, A.C.T. The stain used was Mallory's Triple for connective tissue.

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RESUME.

TARLTON RAYMENT, 1951. Biology of the Reed-bees, *Exoneurae,* with Descriptions of Three New Species and Two Allotypes.

The first account of the life-history of these remarkable bees, which are endemic to Australia. The feeding habits, development of the larvae, and the behaviour of the individual are investigated, and the larval appendages and ivory-coloured face-marks of many species are figured.

The author suggests that the "arms and fingers" of the larvae are not pseudopodia, but exudatoria, for he observed the larvae sucking the appendages, one after another, and concluded that a lipoid may be obtained in that manner.

The rectal glands are compared with those of *Halictus,* and it is probable that the organs are small in species that feed progressively a rich secretion to the larvae, i.e., *Apis* and *Exoneura,* but very large in species supplying a simple pudding of honey and pollen to the young, i.e., *Halictus.*

The author warns taxonomists of the dangers of describing as new any specimen in the absence of the larvae, which possess very good specific characters, though the adults may be exceedingly difficult to separate. The *Exoneurae* are definitely social bees of a simple organisation, and not solitary, as was hitherto believed.

The paper is illustrated with 6 Plates and 2 Text-figures.

A mite, *Tyrofagus tenuiclavus,* is recorded from Australia for the first time.

New specific names: *Exoneura angulata, E. subexcavata, E. richardsoni,* spp. n. and *E. asimillima,* emend. for *simillima* Rayment.

★

THE HUMMING BIRD.

By Tom Iredale.

The Humming Bird is about as well known as any kind of bird, although it is not Australian and no near relatives occur in this country. In South America the class is represented by very many kinds, all small to very small, of resplendent plumage and commonly with quaint modifications of bill, wings and tail. They are remarkable for their rapid quick flight, although it is not now believed that they can fly at hundreds of miles per hour.

A vague connection with Australia is through our famous Gould, whose hobby (we may call it) was this class of bird. Gould was originally a taxidermist, and though he later became famous as a bird illustrator, bookseller, man of business, he always maintained his skill in his early art. Thus he used to secure every new Humming Bird for his collection and set it up in appropriate style in a case until the famous Exhibition of 1851 was mooted. He at once saw a chance of showing off his skill and probably making money at the same time and secured a site in the Show Grounds. He then built his own little Exhibition of Humming Birds, and probably to his own astonishment it became one of the chief attractions and he made a lot of money out of it. Moreover, a small book was written about Humming Birds, based on this exhibition by a popular writer named Martin. Gould himself had begun one of his great folio works on the subject, which was completed in 1861, but Gould was still interested in Humming Birds right up to his death twenty years later. When the Exhibition was closed, Gould had a large exhibition gallery prepared in his own home and his beloved Humming Birds remained there until his death, when they were purchased by the British Museum. The collection was on show there for many years (maybe is still), testifying to his great skill in displaying these minute and fragile gems. But the cause of this note is a different "Humming Bird", a periodical issued under that name by another great lover of these beautiful, even bizarre, jots of bird-life.

A naturalist traveller, Adolphe Boucard, collecting in Mexico and South America, became greatly attracted to these little birds, and emulated a continuation of Gould's work. Becoming a dealer, he had every opportunity of acquiring specimens and maintained a magnificent collection. In 1890 he transferred his business from Paris to London and began a small periodical which he named "The Humming Bird". As a sub-title he added, "A Monthly Scientific, Artistic and Industrial Review", Guaranteed Circulation 5,000. The first number, dated January 1, 1891, is a small quarto of eight pages of advertising matter and eight pages of text, a large reproduction of a photograph of the Editor, signed A. Boucard, being added. The Preface begins: "The 'Humming Bird' will be a monthly Record of everything new in the *Scientific, Artistic and Industrial World,* passing from one subject to another, as its Synonym does when he is on the wing, flying from one plant to another in search of food. At times it will fly at great distances to see what is going on there and will return as quickly to its native place as often as necessary." The Editor kept his promise and a very varied fare was offered. The book seems to be very rare and does not appear in Mathews' Bibliography as possessing any Australian interest. However, a new Bird of Paradise was described therein and it became necessary to examine the work, Casey Woods' good description of the magazine whetting the appetite. I have managed to secure a copy which allows the present notice.

I was surprised to find two notices relative to Australian birds which have hitherto been overlooked. On p. 27, Apl. 1, 1891, appears an article, "Notes on the Crowned Superb Warbler, *Malurus coronatus,* Gould", signed Walter Burton. In this note Burton records that he accompanied Bowyer-Bower on his fatal trip. Sharpe recorded in the Hist. Coll. Nat. Hist. Brit. Mus., Vol. II., p. 317, under Bowyer-Bower, "took with him as assistant, Mr. Walter Burton, a first-rate taxidermist, one of the sons of Henry Burton, a well-known taxidermist, of Wardour Street (London)".

On p. 53, July 1, 1891, another article, "Notes on the Great Bower-Bird, *Chlamydodera nuchalis* Jard.", was contributed by Burton. This seems all, but on p. 7 Boucard began "An Easy Way of Making One Hundred Pounds Sterling a Year by collecting Specimens of Natural History at Leisure Time". A short second article completed this effort, but in the March number another series with the same title to the end of "Year", was begun by Walter Burton, based mostly on his Australian experience, and after his second article a last one by Boucard was added and the whole five indexed as by Boucard and Burton.

At the end of the first year Boucard thanked his subscribers and correspondents and hoped to make Vol. II. even more interesting by the addition of the "Genera of Birds" which he had been working on since 1876, and would begin with the Genera of the Humming Birds. It was reduced to small octavo in size and continued monthly through 1892, but in 1893 it lapsed to a quarterly and slowly faded away in December, 1895. He had, however, managed to issue his Genera of Humming Birds, but he never got any farther with the larger "Genera of Birds".

There is nothing of Australian interest in the last four volumes, but to the omnivorous general reader this Humming Bird would be intriguing matter, as Boucard was involved in the Panama Canal imbroglio and he attempted to salvage his holdings probably without much success. Boucard also discusses the British Museum as seen by a Frenchman, the World's Fair at Chicago, the Zoological Gardens of London, the McKinley Tariff, &c., &c., always interspersing notes on his Humming Birds. The latter volumes are filled up with contemporary notices of books and many obituaries of naturalists.

Adolphe Boucard was born in 1839 and died Dec. 15, 1904, and there is an Obituary Notice in the Ibis, 1905, p. 299.

'The popular writer named Martin", mentioned above, was William Charles Linnaeus Martin (1798-1864), a friend and adviser of Gould in his early days at the Zoological Society.

AGAIN GOULD.

An Amazing Discovery.

By Tom Iredale.

Gould admirers, all over the world, will be pleased to hear that a large number of pattern plates of his Birds and Mammals of Australia are now preserved in the Commonwealth National Library at Canberra. These had long been kept in the safe at the Museum of Technology in Sydney, until recently it was decided that they would be of more service in the National Library, where they would be available to students.

I have been allowed by the authorities of both Institutions to make notes for publication of these wonderful Gouldiana, and to them the thanks of myself and all ornithologists are sincerely rendered. Firstly, the progress of a colour-lithograph must be explained, as it is not well known to the present generation. The first act in the procedure is a rough sketch of the idea of the picture: when this is agreed upon the artist makes a finished painting. This is handed to the lithographer, who etches in reverse on the lithographic stone, and from the stone proofs are printed. These are in faint black and white (really grey and yellowish) and one of these is coloured to agree with the artist's painting. When this is passed as accurate it becomes the pattern or "Key Plate", and the series are coloured by hand in agreement and hence the name hand-coloured lithographs. These patterns become somewhat worn through the handling and are commonly discarded as having served their purpose and usually disappear without trace.

The discovery of a large number of the patterns of Gould's Birds and Mammals of Australia between eighty and one hundred years old was therefore very unexpected and the complete story is not yet quite disclosed. The series here dealt with include most of the plates published as the Supplement to the Birds of Australia and most of the Mammals of Australia. The patterns are included in five covers labelled "Birds of Australia (Supplement) Key Plates, part 1, 2, 3, 4, 5 respectively" agreeing with the five parts of the Supplement which appeared between the years 1851 and 1869. The covers are old boards of the Birds of Australia, indicating that they were preserved by the Publishers with access to spare unused covers. The patterns have comments generally made by Gould in his slapdash writing with a soft pencil, so that many words have become smudged and illegible. The remarks generally refer to the colouring of the soft parts or other details, but many are unmarked: thus the first plate is pencilled "Ptiloris Magnifica. Remarks: The legs and feet must be pale lead colour [some other words smudged]. Eyes umber brown; claws black [some other word smudged]". A magnificent double plate of the New Zealand Mystery Bird, the Takahe, whose mystery has been so astonishingly solved quite recently, was apparently beyond criticism, as it is quite unmarked. On another plate after pencilled instructions a date is added in ink, Saturday noon 7th and on another Monday 11th, apparently dates when the instructions should be completed. In connection with the plate of the head of the Palm Cockatoo the note reads: "Iris purple-brown. Cheeks pale dull crimson tinged all round the edge with pale yellow which usually passes into (hazel)". Again, dealing with the Yellow Fig Bird, is noted in pencil "Brighter" against breast and eye patch; then in ink, "The breast to (be) done with ground Gamboge should be very bright and delicate", then in pencil, "bare space round eye of the male *much brighter*". An interesting comment appears in connection with "Megaloprepia" back more golden a little; then follows a pencil description, "Carpophaga assimilis Gould differ from puell of Teminck which is from N. Guinea in its large size (in its back be more golden (or sulphur) green, in the more strong yellow marks across the shoulder which are more spots—puella in having more orange under tail coverts, the face of puella is lighter, more grey than affinis (affinis crossed out and assimilis

written in); affinis (again correction to assimilis), in fact, is intermediate between magnifica and puell". One note partially smudged is initialled J.G. As noted above, many patterns were passed without criticism. With regard to the Mammals a few comments were made and some of these are of great interest, especially the first one: "Be so good as to keep the work close as *possible* to the Pattern, as Mrs. Gould *complains* of the least deviation, &c. J.G." This note is written in ink and pasted on. Another comment reads, "See that all the greys are *full* as *light* and *warm* as the Pattern. x Centre of breast full strong. Dark mark on the body of the animals are full black in the Pattern". Then H. C. Richter came upon the scene, due to Mrs. Gould's unfortunate and untimely death, and it is interesting to see the earliest plates signed H.C.R. 1841 and here the note reads: "Increase the colouring of animals *not so much* as in the large figures. A little more than it is here. W.H." What W.H. stands for is unknown.

A note of explanation must be given regarding some of these plates. The Mammals of Australia was illustrated by Gould after he had begun the Macropodidae and he used some of the plates from that unfinished work in the latter greater project. This was issued in parts between the years 1845 and 1863, and consequently the note about Mrs. Gould referred to the earlier work as also the early plates of H. C. Richter.

The sequel is not yet disclosed, but it appears from a letter in the possession of Mr. John Ramsay, son of E. P. Ramsay, at the time Curator of the Australian Museum, Sydney, that the whole of the Pattern Plates for the Birds of Australia should be somewhere in Sydney. So the search will go on.

AUDUBON IN AUSTRALIA.

By Tom Iredale.

One of the most romantic episodes in Australian ornithological history came to light last year when it became known through the cognizance of Mr. E. J. Hallstrom that the last lineal male Audubon was a resident in Australia.

John James Audubon died in America on January 27, 1851, and since that date has become the inspiration of bird preservation in that country, the Audubon Society being the largest instrument for bird protection in the world. Audubon became famous in his lifetime from the publication of his grandiose and novel paintings of birds, a task which almost dismayed him at the time. His life, wanderings in pursuit of birds, and his difficulty in getting his pictures published, have been well described and this work is now itself almost a classic. Fame in one direction is generally restricted to the students of the matter detailed, although a fleeting universal interest is sometimes gained. Consequently, while Audubon is a national name in America and is well known to international ornithologists, it is absolutely unfamiliar to Australians generally. Hence the fact that the grandson of this famous American had settled early in his life in Australia and lived many years, leaving a son and daughter, who have continued to the present day, meant nothing to their neighbours. Paintings by the latter's famous great-grandfather hung upon the walls of their dwelling, but even these aroused no comment, and only now, a century after the death of Audubon, has this fact become generally known. This is due, as above noted, to Mr. Hallstrom, who got in touch with Mr. Len Audubon and secured from him some books which are of great interest to Australians. These books had been presented to the great-grandfather of Mr. Len Audubon, John James Audubon, the artist, by John Gould, a younger contemporary who was paying homage to the more famous American in presenting copies of his less (but now scarcely less famous) pretentious illustrated works.

Audubon, in his early forties, reached England in 1826 in the hope of publishing his huge pictures; huge, for Audubon had selected an outsize one metre, i.e., three feet three inches by two-thirds of a metre, two feet two inches, for his work. This size is called elephant or double elephant folio and is the largest size ever used for bird pictures and then only by Audubon. Gould was content with an imperial folio measuring less than two feet by less than eighteen inches. Gould had published the Birds from the Himalayas and then concluded his Birds of Europe, ranking him only a little lower than Audubon. Whether these two greatest of ornithologists ever met is not known at present, as there is no mention in Audubon's diaries, while the busy Gould had no time for such a detail as a diary.

But the books in the possession of Mr. Len Audubon had been presented by Gould just before he left for Australia, and consisted of two parts of his Monograph of the Trogonidae (issued in three parts), two parts of the Icones Avium (all that were issued of this project) and two parts of the Birds of Australia and the Adjacent Islands (now known as the cancelled parts), one of the rarest of all Australian bird books. This is of considerable interest, as all the copies were replaced when Gould restarted his work anew after his return from his unexampled successful trip to Australia. There is no comment by Audubon on anything in these Australian parts, but there are two notes in the other works worthy of record.

Thus in the Icones Avium, Part I., dealing with *Microura squamata* Gould, Scaly-breasted Little-tail, Gould observes, "The great length of its tarsi, and the rounded and concave form of its wings at once *indicate its partiality to the ground*". A pencil note reads: "x Concave-winged Birds belong both to the *Water* and the Land. Therefor this character is of little importance in *this species.* Audubon".

Part II. of the Monograph of the Trogonidae has written at the top in Gould's

hand writing, "J. J. Audubon, March 21st, 1836, London", and in text of plate 2 *Trogon narina* Gould repeated Levaillant's note; "The nest is placed in holes of trees; the eggs are four in number, almost round, and of a rosy white; the female sits for twenty days, and the moment the young are excluded they take flight and follow their parents for a considerable period". The last sentence is underlined in pencil and a pencil note by Audubon reads: "This beats my little Humming Birds, which cannot fly until they are one week old. Pray show this paragraph to Charles Watterton, "*Esquire* of Walton Hall". There is a story behind this, as Neville Wood wrote: "The accuracy of these (Audubon's) biographies has been doubted by our amiable friend, Mr. Waterton, of Walton Hall". These presentation copies had been in the possession of the Audubons for all these years and had travelled from America to Australia, and the present Audubon was born in Australia. Curiously enough his father was born in England when his parents were there on business matters. Mr. Len Audubon thus becomes a perfect example of the unity of nations, as the parents of John James Audubon, his great-grandfather, were French and Spanish.

NOTES ON THE MONOGRAPH OF TROGONS.

Recent bibliographers have apparently known little about the publication of this monograph. In the British Museum (Nat. Hist.) Catalogue, 1904, appeared "A monograph of the Trogonidae, or family of Trogons. 36 pls. col. with descriptive letterpress, fol., London, 1838". Sherborn (1922) added nothing to this. Zimmer (1926), whose bibliographic work in the Ayer Catalogue is excellent, shed some light by citing "1836-38. Published in three parts. Part I. is mentioned by Swainson—therefore must date 1836 or earlier. I do not know what species were included in this part. Later Swainson cited species from Gould so that those species were undoubtedly included in Part I., or in Parts I. and II. if both were in print before July, 1837". Casey Wood (1931) apparently did not have this issue, as he cited "The present edition is the second, the first appearing in 1838". Going back to contemporaries, Engelmann (1846) wrote "36 species, 3 Pts. in 1 Vol., with descriptive letterpress and 36 beautifully coloured plates in Imp. fol. Ibid [that is London], 1838". However, Neville Wood in his "Ornithologists' Text Book, published May, but with preface date Jan. 1, 1836, included "Monograph of the Trogonidae, by John Gould, London, 1835, folio". This is confirmed in Weigmann's Arch fur Natur, Vol. II., 1836, p. 268, wherein Part I. is recorded as having appeared in 1835. Hence we have dates 1835 to 1838 for the issue of the three parts, but no details of contents. Therefore, the present find solves all the matters in doubt, though the first part is not available. The cover is, and the contents can be, recovered by means of elimination.

The cover reads: A/Monograph/of the/Trogonidae/or Family of Trogons/by/ J. Gould,/F.L.S./Part I./(To be completed in three parts)/Price £2.2.0/London./ Published by the Author, 20, Broad Street, Golden Square./1835/Printed by C. Hullmandel./

Part 2 is the same cover with alteration only in the part and price, the part number being altered to 2, and the price to £2.10.0, the alterations being in manuscript. This cover bears at the top, "J. J. Audubon, March 21st, 1836, London", in three lines in Gould's handwriting.

The contents are one plate and one page text corresponding, the Latin name under the plate succeeded by a vernacular, and the text similarly headed. The following is the order, but the plates are not numbered, nor, of course, is the text:—

1. *Trogon temnurus,* Temm. Cuba Trogon.
2. *Trogon narina,* Levaill. Narina Trogon.
3. *Trogon duvaucelii,* Temm. Duvaucel's Trogon.
4. *Trogon variegatus,* Spix. Purple-breasted Trogon.
5. *Trogon surucura,* Vieill. Surucua Trogon.
6. *Trogon melanocephala,* Gould. Black-headed Trogon.
7. *Trogon pavoninus,* Spix. Pavonine Trogon.
8. *Trogon melanopterus,* Swains. Black-winged Trogon.

9. *Trogon diardii,* Temm. Diard's Trogon.
10. *Trogon melanopterus,* Swains. Black-winged Trogon.
11. *Trogon collaris,* Vieill. Collared Trogon.
12. *Trogon meridionalis,* Swains. Little Trogon.

The cover of Part 3 is the same as the preceding, save that the part and the phrase have been erased, leaving only the "Price L" in the space. Then "Part 3" has been written in, and the L after Price crossed and 2.18.0 added. The final 5 in the date has also been altered so that it now reads in print 1838. So that we now have the following data:—

Part I.—Eleven plates and text, 1835. Price £2.2.0.

Part II.—Twelve plates and text, 1836. Price £2.10.0.

Part III.—Thirteen plates and text, 1838. Price £2.18.0.

At the beginning of Part III. is a Preface, Introduction, Synopsis Specierum, List of Subscribers and a List of Plates (to be used for the order in which the plates were to be arranged when bound).

Part III.

1. *Trogon massena,* Gould. Prince Massena's Trogon.
2. *Trogon caligatus,* Gould. Booted Trogon.
3. *Trogon aurantius,* Spix. Orange-breasted Trogon.
4. *Trogon pulchellus,* Gould. Beautiful Trogon.
5. *Trogon roseigaster,* Vieill. Rosy-vented Trogon.
6. *Trogon fulgidus,* Gould. ——— (Shining Trogon on plate).
7. *Trogon citreolus,* Gould. ——— (Lemon-breasted Trogon on plate).
8. *Trogon hodgsonii,* Gould. Hodgson's Trogon.
9. *Trogon ardens,* Temm. Rosy-breasted Trogon.
10. *Trogon neoxenus,* Gould. Welcome Trogon.
11. *Trogon macroura,* Gould. Large-tailed Trogon.
12. *Trogon melanurus,* Swains. Black-tailed Trogon.
13. *Trogon gigas,* Vieill. Giant Trogon.

The List of Plates gives them in the following order which is, as bound, as these numbers are cited by Gray in his Handlist in 1870, before the second edition was issued.

The volume arrangement, then, is:—

Plate 1. *Trogon mexicanus,* Swains (ad. male). Issued in Part I., 1835.
2. *Trogon mexicanus,* Swains (young male and female). Part I., 1835.
3. *Trogon elegans,* Gould. Part I., 1835.
4. *Trogon ambiguus,* Gould. Part I., 1835.
5. *Trogon collaris,* Vieill. Pl. 11, Part II., 1836.
6. *Trogon variegatus,* Spix. Pl. 4, Part II., 1836.
7. *Trogon caligatus,* Gould. Pl. 2, Part III., 1838.
8. *Trogon atricollis,* Vieill. Part I., 1835.
9. *Trogon meridionalis,* Swains. Pl. 12, Part II., 1836.
10. *Trogon melanopterus,* Swains. (male & female). Pl. 10, Part II., 1836.
11. *Trogon melanopterus,* Swains. (young male). Pl. 8, Part II., 1836.
12. *Trogon melanocephala,* Gould. Pl. 6, Part II., 1836.
13. *Trogon citreolus,* Gould. Pl. 7, Part III., 1838.
14. *Trogon aurantius,* Spix. Pl. 3, Part III., 1838.
15. *Trogon surucura,* Vieill. Pl. 5, Part II., 1836.
16. *Trogon massena,* Gould. Pl. 1, Part III., 1838.
17. *Trogon macroura,* Gould. Pl. 11, Part III., 1838.
18. *Trogon melanura,* Swains. Pl. 12, Part III., 1838.
19. *Trogon albicollis,* Swains (temnurus). Pl. 1, Part II., 1836.
20. *Trogon roseigaster,* Vieill. Pl. 5, Part III., 1838.
21. *Trogon resplendens,* Gould. Part I., 1835.

22. *Trogon pulchellus,* Gould. Pl. 4, Part III., 1838.
23. *Trogon pavoninus,* Spix. Pl. 7, Part II., 1836.
24. *Trogon fulgidus,* Gould. Pl. 6, Part III., 1838.
25. *Trogon neoxenus,* Gould. Pl. 10, Part III., 1838.
26. *Trogon narina,* Levaill. Pl. 2, Part II., 1836.
27. *Trogon reinwardtii,* Temm. Part I., 1835.
28. *Trogon gigas,* Vieill. Pl. 13, Part III., 1838.
29. *Trogon temminckii,* Gould. Part I., 1835.
30. *Trogon diardii,* Temm. Pl. 9, Part II., 1835.
31. *Trogon malabaricus,* Gould. Part I., 1835.
32. *Trogon duvaucelii,* Temm. Pl. 3, Part II., 1836.
33. *Trogon erythrocephalus,* Gould. Part I., 1835.
34. *Trogon hodgsonii,* Gould. Pl. 8, Part III., 1838.
35. *Trogon ardens,* Temm. Pl. 9, Part III., 1838.
36. *Trogon oreskios,* Temm. Part I., 1835.

WESTERN AUSTRALIAN BIRD BOOKS.

By TOM IREDALE.

Some time in 1948 there was issued in Western Australia "A Systematic List of the Birds of Western Australia", by H. M. Whittell and D. L. Serventy. Some time is written advisedly, as the Preface is dated June 4, 1947, the Foreword September, 1948, and the Title Page 1948, and the copy received by me direct on August 23, 1948. This is an invaluable List, as hitherto the only catalogue available seems to have been one that appeared in the W.A. Year Book for 1900-1, prepared by B. Woodward from notes by A. W. Milligan and published as long ago as 1902. The present List is based on Mathews' Lists with emendations from oversea ornithologists incorporated, although it professes to follow the "Official Check-List" of 1926. All the synonyms relating to Western subspecies are recorded without indication by the authors of any preference, which is all to the good. The Western Australian avifauna still provides many problems of distribution and will take many years to elucidate thoroughly, but it is certain that this List will prove exceedingly useful in that connection. Complaint might be made of certain eccentricities, but these will straighten themselves out with the progress that will eventuate in the near future through the production of a finer and more interesting work by the same authors. The latter is a fine octavo volume of some 365 pages, with two coloured plates, thirty-two text-figures, and a map. It is entitled "A Handbook of the Birds of Western Australia (with the exception of the Kimberley Division)", "published November, 1948", but the names of the authors have been transposed so that these now read D. L. Serventy and H. M. Whittell. It is well-planned work with an introduction giving Aboriginal Names, Descriptions of the Species, Distribution, Nesting and Habits, etc. A section follows dealing with "The History of Western Australian Ornithology", which will be read with great interest by all ornithologists; this is based on Alexander's articles, which are now rare and were never well publicised, with much additional information by Whittell, whose investigations into this branch of ornithology have produced much valuable novelty. Possibly the succeeding section, Bird Geography, will create even more interest, as this subject is of great importance everywhere, and additional local information is very welcome. The rest of the book deals with the birds in the order of the Systematic List, but with still more alterations, so that the divorce from the "Official Check-List" becomes more pronounced. The descriptions are full and practically complete, while the field notes are, of course, more or less novel, as the scattered observations had not previously been brought together under a provincial title. It is especially noteworthy for its very complete indices.

This is the best bird book yet produced on local Australian ornithology and should be followed by other State works, especially for New South Wales and Queensland, as South Australian and Victorian essays are already in train. It is very pleasing to record that a new edition has been called for, and was issued in February of this year (1951). It includes four more coloured plates, fourteen more text-figures and nineteen more pages of text.

THE NATURALIST'S LIBRARY.

An Essay in Bibliography.

By Tom Iredale.

(Plates xxxiii.-xxxiv. and text-figure.)

The dictionary meaning of bibliography is, "The knowledge and history of books". An even better definition is found in an Encyclopaedia: "The word formerly meant the writing or transcription of books; but for nearly a century now [1914] the word has come to mean expert writing on books and MSS. with regard to points of variation between different editions, questions of authorship, binding, type, &c." A common use of the word to-day is merely a list of books referred to in the preparation of an article or book. The present use is the history of the publication of the abovementioned work and in attempting to unravel this attention must be given to so many obscure points that it seemed useful to indicate such in an article for the use of intending bibliographers in any sense. The work noticed was published in forty volumes between the years 1833 and 1843 and has been reprinted many times since. It was a publishing venture of the house of Lizars of Edinburgh, and the Editor was Sir William Jardine, who was also the writer of several of the volumes. Hence it is commonly cited as Jardine's Naturalist's Library. It started in a small way, but was so successful that reprints, alterations, improvements abound and the data of the original series are still confused.

When I was associated with Mathews we, with the assistance of Sherborn and others, worked out the necessary items for the volumes dealing more or less with Australian birds. When, however, I collaborated with Troughton in the preparation of "A Check-List of the Mammals recorded from Australia", I had to begin again upon the mammal series, and found inaccuracies everywhere. The data provided in the Catalogue of Books in the British Museum, the dates given by Sherborn, Palmer's Index, Engelmann's Index, Casey Wood's Introduction and Zimmer's Catalogue all proved erroneous in small details (small be it noted), but all the above are practically models of accurate work. Inasmuch as all the above have been unable to reach conclusively the truth about the issues of this work, I will not claim finality, either, but provide the present study as a basis for other students to whom more facilities for research are available.

The series of forty volumes covers Mammals, Birds, Fishes and Insects, but were issued individually without reference to any group order and were later arranged into groups as above. An attempt was made to cover the desires of buyers for such rearrangement so that no less than three title-pages were provided in each volume, while the spine conveyed the nature of the contents in different language. In case this may read somewhat complicated, No. XII. may be cited as an example. The twelfth volume to be issued has title No. 1: The Naturalist's Library. Mammalia, Vol. IV., with a cut of The American Bison. Then comes a page with, in the centre, The/Natural History/of the/Ruminating Animals. This is succeeded by another title-page: The/Naturalist's Library./Mammalia,/ Vol. IV./Ruminantia./Part II./By/Sir William Jardine, Bart./&c. Then follows another title-page: The/Natural History/of the/Ruminating Animals,/containing/Goats, Sheep, Wild and Domestic/Cattle, &c./Illustrated by thirty-three plates, with/ memoir and portrait of John Hunter.)/Part II./By/Sir William Jardine, Bart./the last two with the date 1836 at bottom. Then the spine is lettered Naturalists/ Library/Mammalia,/Vol. IV./Goats, Sheep,/&c. The size of the page is $6\frac{3}{4}$ inches by $4\frac{1}{4}$ inches, and in their advertisement the publishers called this "Foolscap 8vo".* In the British Museum Catalogue this is accepted, but Bashford Dean in one place calls it 16o and in another 12mo. The publisher's announcement states that the cover is "extra Morocco cloth boards" and the colour as "maroon", but at the present time the colour has faded to various shades of

* 8vo is an abbreviation for octavo, 16o for sixteenmo and 12mo for duodecimo. See post.

brown. This is the original cover which was used from 1833 to 1843, and sets so covered are regarded as belonging to the original issue. This is where the first stumbling block appears, as through the increasing sales back numbers had to be reprinted and sometimes amended without any other indication than a mere change of the date on the title-pages, and not always that.

Preceding the Frontispiece and Title-pages is a "List of Volumes/of the/ Naturalist's Library,/in the order in which they were published", and at the end "Advertisement Sheets" from which valuable information may be secured. These, of course, are missing in all later published copies. The names cited in this List do not exactly coincide with the title-page words, as while the twelfth volume, above cited, gives "Ruminating Animals", the thirteenth shows "Pachidermata", the title-pages read "Pachydermes", on the spine "Elephants, &c." This last volume-name must have worried the editor or publisher, for when a new title-page was issued in 1843 under the new group-arrangement, the title-page records "Mammalia. Thick-skinned Quadrupeds", this change appearing first in the list in the thirtieth volume. In order to check the stages of rearrangement it will be best to use the second title-page, which gives all the details, but they will be listed first in the order in which they were issued, although this does not appear elsewhere than on the printed fly-sheet (whose wording sometimes differs).

Order of Issue	Group Arrangement	Author	Printed by	Date
Vol. I.–	Ornithology, Vol. I., Humming Birds	Jardine	Ballantyne & Co.	1833
II.–	Mammalia, Vol. I., Monkeys	Jardine	M. Aitken	1833
III.–	Ornithology, Vol. II., Humming Birds	Jardine	Neill & Co.	1833
IV.–	Mammalia, Vol. II., The Felinae	Jardine	Neill & Co.	1834
V.–	Ornithology, Vol. III., Gallinac. Birds	Jardine	Neill & Co.	1834
VI.–	Ornithology, Vol. IV., Gallinac. Birds, Part II., Game Birds	Jardine	Neill & Co.	1834
VII.–	Ichthyology, Vol. I., The Perch Family	Jardine	And. Shortrede	1835
VIII.–	Entomology, Vol. II., Beetles	Duncan	Stevenson & Co.	1835
IX.–	Ornithology, Vol. V., Gallinac. Birds, Part III., Pigeons	Selby	Neill & Co.	1835
X.–	Entomology, Vol. III., Brit. Butterflies	Duncan	Neill & Co.	1835
XI.–	Mammalia, Vol. III., Ruminantia, Part I.	Jardine	Neill & Co.	1835
XII.–	Mammalia, Vol. IV., Ruminantia, Part II.	Jardine	Neill & Co.	1836
XIII.–	Mammalia, Vol. V., Pachydermes	Jardine	And. Shortrede	1836
XIV.–	Entomology, Vol. IV., Brit. Moths, &c.	Duncan	Lizars	1836
XV.–	Ornithology, Vol. VI., Parrots	Selby	Neill & Co.	1836
XVI.–	Mammalia, Vol. VI., Ordinary Cetacea or Whales	No author	Lizars	1837
XVII.–	Ornithology, Vol. VII., Birds of Western Africa	Swainson	Lizars	1837
XVIII.–	Entomology, Vol. V., Forgn. Butterflies	Duncan	Lizars	1837
XIX.–	Ornithology, Vol. VIII., Birds of Western Africa II.	Swainson	Lizars	1837
XX.–	Ornithology, Vol. IX., Birds of Gt. Britain and Ireland	Jardine	And. Shortrede	1838
XXI.–	Ornithology, Vol. X., Flycatchers	Swainson	Lizars	1838
XXII.–	Mammalia, Vol. VII., Brit. Quadrupeds	MacGillivray	Lizars	1838
XXIII.–	Mammalia, Vol. VIII., Amph. Carnivora	Hamilton	Lizars	1839
XXIV.–	Ornithology, Vol. X., Birds of Gt. Brit. and Ireland, Part II.	Jardine	And. Shortrede	1839

XXV.–	Mammalia, Vol. IX., Dogs	Ham-Smith	Lizars	1839
XXVI.–	Entomology, Vol. VI., Bees	No author	T. Constable	1840
XXVII.–	Ichthyology, Vol. II., Fishes	Bushnan	Lizars	1840
XXVIII.–	Mammalia, Vol. X., Dogs	Ham-Smith	Lizars	1840
XXIX.–	Entomology, Vol. I., Introduction to	Duncan	T. Constable	1840
XXX.–	Mammalia, Vol. XI., Marsupialia	Waterhouse	T. Constable	1841
*XXXI.–	Mammalia, Vol. XII., Horses	Ham-Smith	Lizars	1841
XXXII.–	Ichthyology, Vol. III., Fishes of Guiana, Part I.	Schomburgk	Lizars	1841
XXXIII.–	Entomology, Vol. VII., Exotic Moths	Duncan	Lizars	1841
XXXIV.–	Ornithology, Vol. XII., Birds of Gt. Britain and Ireland, Part III.	Jardine	Lizars	1842
XXXV.–	Mammalia, Vol. XIII., Introduction to	Ham-Smith	Lizars	1842
XXXVI.–	Ornithology, Vol. XIII., Nectariniadae	Jardine	Lizars	1843
XXXVII.–	Ichthyology, Vol. IV.—Brit. Fishes, Vol. I.	Hamilton	Lizars	1843
XXXVIII.–	Ichthyology, Vol. V., Fishes of Guiana, Part II.	Schomburgk	Lizars	1843
XXXIX.–	Ichthyology, Vol. VI., Brit. Fishes, Vol. II.	Hamilton	Lizars	1843
XL.–	Ornithology, Vol. XIV., Birds Gt. Brit. and Ireland, Part IV.	Jardine	Lizars	1843

Having numbered the groups as above in the last volume, a new series of title-pages is given, reading, "The/Naturalist's Library/Edited by/Sir William Jardine, Bart.,/F.R.S.E., F.L.S., etc., etc./ Vol. I./Mammalia./Introduction to Mammalia/By Lieut.-Col. Charles Hamilton Smith, &c., 1843. Vol. II., Monkeys. Vol., III., Lions, Tigers. Vol. IV., Dogs, Part 1st. Vol. V., Dogs, Part 2nd. Vol. VI., Amphibious Carnivora. Vol. VII., Whales. Vol. VIII., Marsupialia. Vol. IX., Thick-skinned Quadrupeds. Vol. X., Goats, Sheep. Vol. XI., Deer. Vol. XII., Horses. Vol. XIII., British Quadrupeds. Then Vol. XIV., Ornithology, Humming Birds, Part 1st. Vol. XV., Humming Birds, Part 2nd. Vol. XVI., Sun-Birds. Vol. XVII., Flycatchers. Vol. XVIII., Parrots. Vol. XIX., Pigeons. Vol. XX., Gallinaceous Birds. Vol. XXI., Game Birds. Vol. XXII., Birds of Western Africa, Part 1st. Vol. XXIII., Birds of Western Africa, Part 2nd. Vol. XXIV., British Birds, Part 1st. Vol. XXV., British Birds, Part 2nd. Vol. XXVI., British Birds, Part 3rd. Vol. XXVII., British Birds, Part 4th. Now Ichthyology. Vol. XXVIII, Fishes (Structure). Vol. XXIX., Fishes of the Perch Family. Vol. XXX, Fishes of British Guiana, Part 1st. Vol. XXXI., Fishes of British Guiana, Part 2nd. Vol. XXXII., British Fishes, Part 1st. Vol. XXXIII., British Fishes, Part 2nd. Vol. XXXIV., Entomology, Introduction to. Vol. XXXV., Beetles. Vol. XXXVI., Foreign Butterflies. Vol. XXXVII., Exotic Moths. Vol. XXXVIII., Bees. Vol. XXXIX., British Butterflies, and Vol. XL., British Moths, Sphinxes, &c.

It will be noted in the first list that no author was given as the writer of the whales, but on the new title-pages appears the name Robert Hamilton. Also in connection with the book on Bees no author was cited, nor does his name appear in the new title-page, but in the advertisement in the front of the fortieth volume, in a list of the Authors' Names and the Subjects treated by such, the Rev. Dr. Dunbar is credited with the volume on the Honey Bee, etc.

These two omissions created a lot of confusion. The essay on whales was attributed by Sherborn to C. Hamilton Smith, while Palmer in one place gave H. Smith (?), but also R. Hamilton. The pagination and date were also given incorrectly by Sherborn, who recorded Jan., 1836. The British Museum Catalogue quoted 1839, while Palmer cited 1839, 1842 and then 1837, which is the correct date, the book appearing in January. In his reference to 1842, Palmer cites

* Although the number is retained, it was explained at the time that Vol. xxxi. appeared before Vol. xxx.

p. 266, so apparently there was an amended edition, as the original ends on p. 264. But I have the original edition with title-page 1843, being Vol. VII. (not Vol. VI., which has the signature Vol. VI.), but with the signature Vol. XXVI., which is unintelligible, as also Sherborn's and Palmer's citation's as Mammalia, Vol. IX. Apparently sheets were used from various issues which had the signatures in accordance with the arrangement adopted, as in one volume the first part is signatured Vol. XXVII., while the latter has the signature Vol. VII., though the title-page itself declares that it is Vol. XXII. As above noted, the first rearrangement began with Mammalia, a revised edition showed the order of the Mammal volumes altered, and then the Bird volumes were placed first and these began with the four volumes of British Birds, thus displacing all the series, and so on. Consequently, recognising the confusion, all the latest series have no volume number at all in the signature, merely the letter.

Upon referring the volume on Bees to my colleague, Mr. A. Musgrave, he could not find Dunbar mentioned, but in one place the book was credited to Duncan, in another to Jardine, as it is in the British Museum Catalogue. That Dunbar is correct is seen in the Advertisement dated Dec., 1838, in the 23rd volume (Mammalia, Vol. VIII., Amphibious Carnivora), where it is written, "A most interesting volume on the history of Bees, by the Rev. William Dunbar, being also in the press, will soon be in the hands of our subscribers".

However, before we retrace our steps, back to the eccentricities seen in the individual volumes, it must be pointed out that all the remarks in the places mentioned as to the reprints and re-issues are at fault. Immediately the series was completed in 1843 and the new title-pages as noted given in the last volume, a re-issue of the whole in a red cloth binding appeared. Whatever the cause, this arrangement was almost immediately forsaken and a new issue in the red cloth with the title-pages dated 1843 was made, beginning with the Birds, then Mammals, Insects and concluding with Fishes. In this case, British Birds begin the series. This red cover has been associated with the name of H. G. Bohn, of London, who somewhere about 1845-6 took over the southern sale from Lizars (who continued the printing for some years), and sold the work for many years, apparently dating many issues, as dates from 1845, 1846, 1848, 1851, 1855, 1861, &c., have been seen. So that at present neither the maroon covers nor the red cloths mean anything by themselves, three or more altered prints may occur in either binding, as some of the original issues have been found bound in red to match the later set.

The project began with Humming Birds and a comparatively small edition was first printed. It proved, however, so successful that a second printing took place within a year and in this alterations were made. It would be an attractive piece of research for someone situated, say, in London, to collect data on the subject of Humming Bird prints alone. The first issue had the plates without backgrounds; a second part had plain backgrounds added, and another edition had the backgrounds coloured. In the first issue the frontispiece of Linnaeus was unsigned and the memoir ran from pages 14 to 48, the work ending at page 147. The second print had a copy of Linnaeus' signature added at the foot of the engraving, while the memoir occupied pages 25-60. In later editions the memoir was much extended. At the foot of the plates of the Humming Birds a Latin name alone was printed at first, but in the second print the English name was added in smaller type in brackets below. The first print is dated 1833, the second 1834, but an advertisement in the second volume, also dated 1833, states, "The above Two Volumes (of the Humming Birds), done up in one, in rich silk binding and gilt leaves, containing Sixty-six Plates, coloured, with the Two Portraits, and Memoirs, price 14s".

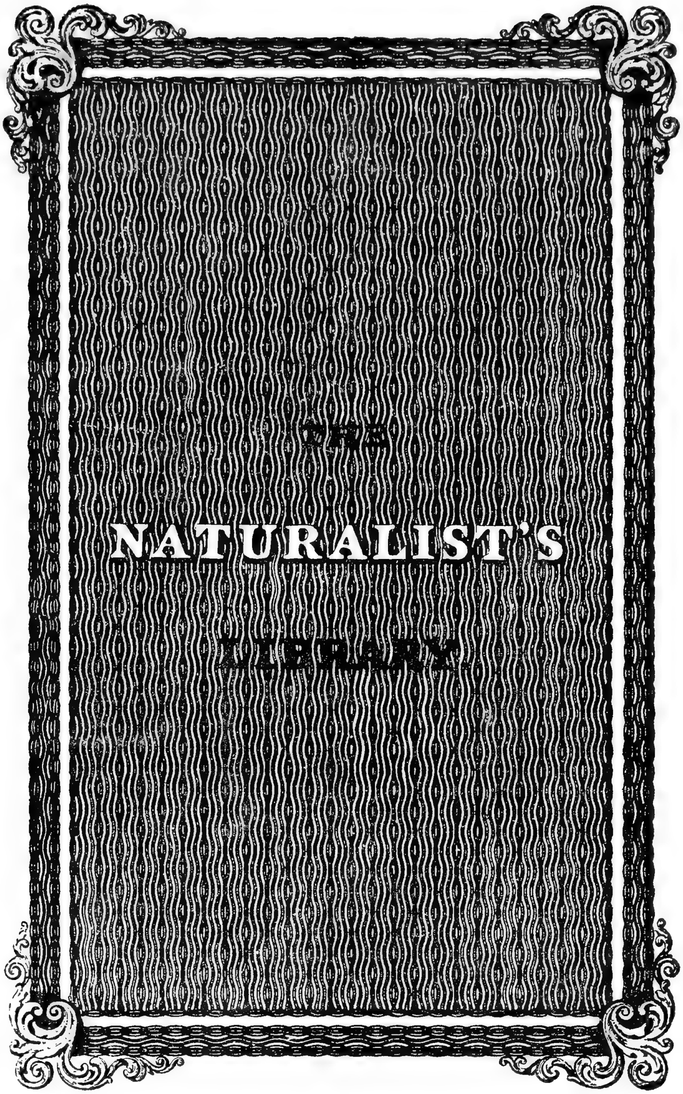
Zimmer notes another special edition issued in 1840, notably having the backgrounds coloured and larger paper. Other dates have been seen for a similar book, but comparison is necessary in every case. In the first issue of the first volume two prints are known, one by Ballantyne, the other by Neill & Co., who printed the second volume. Also a copy of Vol. II. with the backgrounds added to the plates has the title-pages dated 1833, but the advertisement sheets at the back refer to May, 1835, so must have been issued after that date.

In between the appearance of the two volumes of Humming Birds the first volume of the Mammalian series was issued. This dealt with Monkeys and all the early copies examined showed no complication. Then Doctor Frank Marshall showed me his set which proved of great interest. There was an advertisement dated 1846 in the Introduction to the Mammalia, Vol. XV., wherein was noted that the fourteen volumes dealing with Ornithology had been issued and that the thirteen volumes of Mammalia, seven of Entomology and six of Ichthyology should be completed within eighteen months. The Ornithology had begun with the Birds of Great Britain and therein was advertised, "The People's Edition", to appear fortnightly in parts, three parts to a voluume, in paper wrappers, at one shilling and fourpence per part. Apparently this did not eventuate, as nothing has been heard about it save the note by Engelmann, with the same information. But the important volume was Volume XXVII. dealing with Monkeys, which was signatured Vol. XXVII. The Memoir of Buffon occupied pages 17-34, followed by Eloge on Buffon by P. L. Courier (addressed to his fellow citizens, 35-36) 37-59; then came the Monkeys, pp. 67-272. However, this was succeeded by an Appendix: "A few observations on the new illustrations by Mr. James Stewart, the artist who made the drawing", occupying pages 275-288. It then appeared that a large collection of Monkeys had been received by the Edinburgh Royal Zoological Gardens, and when Stewart saw them he made fresh paintings, Plates IX., X., XII., XIII., XIV., XV., XX., XXII., XXIII. and XXVII., from life and these superseded the old ones, an entirely new one being also added on the title-page, all the others being redrawn. Unfortunately, the text was not amended, which it might have been, but Stewart's action deserves the highest commendation. Probably the new illustrations appear in all issues after 1846, as I have an undated copy in the early red cloth which includes the paintings, but the Appendix with the explanations is deleted, and the Contents and Memoir are unpaged, then the Eloge is on pp. 1-23 and the Monkeys pp. 25-230, a stereotype of the first print, and thus the differences might have been overlooked without comparison, which, again, was not suggested. There has not been as much interest in the other groups as in Ornithology, and consequently there is probably much to learn. The bird books have been excellently discussed by Zimmer and there is not a great deal to add, but there are slight differences to note even in this section. Thus the earliest volumes had Latin names only on the plates, and the green fly-leaf was ornamented by a large block of a bookback lettered "The Naturalist's Library". I have copies of the first five volumes in this state, but as above noted, second prints made almost simultaneously lack the adornment on the fly-leaf and generally an English name has been added underneath in smaller type to the Latin name on the plate. In still later issues the country of origin was also added and sometimes, as in the Fishes, the locality in the background is indicated by name. In the early issues the plates were distributed throughout the text, but to fill hurry orders they were lumped together at the end, and this apparently became the practice towards the end of the work. But here again there is no agreement, as in some of the post-1843 issues the plates may be found in the text. Thus I have examined some half dozen copies of the volume on Amphibious Carnivora in the original covering and in each I found the plates at the end, yet a post-1843 copy in the red cover has the plates throughout the text, which is a stereotyped print. The names on the plates in this volume are English only, Latin only, or English and Latin, sometimes with localities.

MEMOIRS.

The immortal section of these little books is that devoted to the account of some great naturalist, accompanied by an engraving. These are very useful for reference, and as the list is given in other places in connection with the volumes, they are here re-arranged in alphabetical order for convenient usage.

Aldrovandi, Vol.	22—British Quadrupeds	A.D. 1522 or 1527—1605
Aristotle	5—Gallinaceous Birds	B.C. 384—321
Azara	28—Dogs II.	A.D. 1746—1805?
Banks	7—The Perch Family	A.D. 1743—1820
Barclay	30—Marsupialia	A.D. 1758—1826
Bewick	15—Parrots	A.D. 1758—1826
Bruce	17—Birds of W. Africa	A.D. 1730—1794



First flyleaf in the first print of copies of The Naturalist's Library, so far only found in the first five volumes.

Buffon	2—Monkeys	(A.D. 1707—1788)
Burckhardt	38—Fishes of Guiana II.	A.D. 1784—1817
Camper	11—Ruminantia I.	A.D. 1722—1789
Cuvier	4—The Felinae	A.D. 1769—1832
De Geer	29—Introd. to Entomology	A.D. 1720—1778
Drury	35—Introd. to Mammalia	A.D. 1725—1804
Gesner	31—Horses	A.D. 1576—1565
Haller	21—Flycatchers	A.D. 1703—1777
Huber	26—Bees	A.D. 1750—1831

Humboldt	39—Brit. Fishes II.	A.D. 1769—[1859]
Hunter	12—Ruminantia II.	A.D. 1728—1793
Lacepede	16—Whales	A.D. 1756—1825
Lamarck	18—Foreign Butterflies	A.D. 1744—1829
Latreille	**33**—Exotic Moths	A.D. 1762—1832
Le Vaillant	19—Birds in W. Africa II.	A.D. 1753—1825
Linnaeus	1—Humming Birds I.	A.D. 1707—1778
Merian	14—Brit. Moths	A.D. 1647—1717
Pallas	25—Dogs I.	A.D. 1741—1811
Pennant	3—Humming Birds II.	A.D. 1726—1798
Peron	23—Amphib. Carnivora	A.D. 1775—1810
Pliny	9—Pigeons	A.D. 19 or 23—75 or 79
Raffles	6—Game Birds	A.D. 1781—1826
Ray	8—Beetles	A.D. 1514—1572
Rondelet	37—Brit. Fishes I.	A.D. 1507—1566
Salviani	27—Fishes	A.D. 1514—1572
Schomburgk	32—Fishes Guiana I.	A.D. 1804—[1863]
Sibbald	20—Brit. Birds I.	A.D. 1640—1722
Sloane	**13**—Elephants	A.D. 1660—1752
Smellie	24—Introd. to Entomology	A.D. 1637—1680
Swammerdam	29—Brit. Birds II.	A.D. 1740—1795
Walker	34—Brit. Birds III.	A.D. 1731—1804
Werner	**10**—Brit. Butterflies	A.D. 1750—1817
Willughby	36—Sun Birds	A.D. 1635—1672
Wilson	40—Brit. Birds IV.	A.D. 1766—1813

Then in a later printing of "Parrots" a Memoir on Daubenton was added at the end. Also note that in Vol. 29 two Memoirs (Swammerdam and De Geer) were included, thus making Forty-two Memoirs in all. Rarely is the name of the author of a Memoir given.

M.B. (Michael Bland) gave a Chronological Table of the Memoirs in the fortieth volume, giving the dates of birth and death as above, but overlooking Buffon (1707-1788).

To recapitulate, the earliest issues in the maroon covers have the block on the flyleaf, and after the first five this has not been seen. However, in the ninth appears a list of volumes as issued and this is found until the fortieth. In the back there is an advertisement sheet from the first to the fifteenth, and occasionally later, though it is sometimes misplaced, being in the front in the eighteenth volume, while throughout the plates should be distributed in the text. The signatures should agree with the number of volumes in the section; that is, Vol. I. will be seen in Ornithology, Mammalia, Ichthyology and Entomology in the first volume of each section, and so on,, so that Vol. XIV. will be the highest signature in the original series. In the earliest books the plates were engraved with the Latin name only, but soon this was emended and in some sections, such as the British Birds, British Fishes and curiously the Birds of Western Africa, only English names appear. In the later prints of the early issues English names were added, and in many cases localities were also added, sometimes above, sometimes below, or even at the side, as the case permitted. Variation in coloration of the plates does not mean anything; it appears purely individual. The text seems always to remain the same; in the later volumes it was stereotyped and thus is constant as long as the books were issued. In some of the early volumes there appear to have been remainders, as the text is identical in the early copies in the red covers. In the early volumes the pagination may differ through the addition of matter to the preceding Memoir, and in three cases additional matter appeared at the end, as in the Gallinaceous birds, twenty odd pages are added on Common Poultry, and to the Pigeons a similar addition on the Rearing, &c., of Domestic Pigeons. A Memoir of Daubenton was added to the end of the Parrot volume, while Bashford Dean has recorded an Appendix to the volume of Perches, consisting of extracts from Walton's "Compleat Angler". There may be many other additions not recorded. All these emendations seem to be due to the unexpected success of the work. The Editor-in-Chief was Sir William Jardine (1800—1874), who advertised "eight or ten volumes of each Mammalia (13), Ornithology (14), Ichthyo-

logy (9) and Entomology (7) will be about the limit". The figures in parentheses give the totals as issued. As subjects selected were included Man, Eagles and Hawks, Creepers and Salmon, all of which fell by the wayside. Man was never mentioned again, although it had been first on the list, while Salmon was included in the "British Fishes", but in the British Museum Natural History Catalogue of Books is an item under Sir W. Jardine: "British Salmonidae, Pt. 1 and 2, 12 pls. col. with descriptive letterpress, fol. Edinburgh, 1839, 1841. No title page. Title taken from wrapper", which suggests an attempt on the subject. Although as above noted Man was never mentioned again, I have just seen in Mr. G. P. Whitley's library in a copy of Fishes of British Guiana (in the red cloth, 4s. 6d. issue) the possible explanation why. In the beginning is an advertisement by S. Highley, the London distributors at the time, which gives a list of the volumes of the Naturalist's Library and then adds a note, "Also, printed uniformly with the Naturalist's Library, and designed as a Supplementary Volume to the Series, The Natural History of the Human Species . . . by Lieut.-Col. C. Hamilton Smith, with very numerous Coloured Plates, price 7s. 6d." This accounts for "Man", but no notice had been previously seen.

Apparently the initial issue was only 2,000 or so, but soon 6,000, 7,000 and even over 11,000 were recorded as being sold. In the advertisement issued in the beginning of the volumes in the original printings an up-to-date little talk is given by the publisher on the progress, and therein are given reasons for delay, &c. Thus Vol. VIII. was on Beetles and lettered Entomology, Vol. II., issued in 1835. It is explained that it is issued before the Introduction to Entomology, which will be Vol. I., but that will soon appear. It did not come out until 1840, and then a reprint of Beetles had to be made, which appeared in 1841 with the original advertisement, but the later list of volumes in front and date 1841. How many re-issues of this wonderful little series have appeared is quite unknown, as the British Museum Catalogue gives re-issue in 1845-6 and Bohn in 1848, but there were two issues in 1843 before the 1845-6 and very many after 1848, dates as late as 1876 being noted. Apparently Bohn took over entirely from Lizars, and many years later transferred their rights to Chatto and Windus, who in their turn handed over to W. H. Allen. The last edition was evidently issued by this firm, who then had a similar series rewritten under the name Allen's Naturalist's Library. This was edited by R. Bowdler Sharpe, and the text matter was entirely new, though the subjects are similar, and it has never been confounded with Jardine's work. It may be met with under the title Lloyd's Naturalist's Library, a stereotype with new title pages only.

The early rate of success can be gauged by the printers employed. The first one was Ballantyne & Co., then O'Neill & Co. were called in, and also M. Aitken to help. The rush for copies continued and Andrew Shortrede, Stevenson and T. Allan & Co. had to assist with some volumes. By this time Lizars had realised that they would have to do something, as they began their own printing in 1836 and continued for many years. But even they found it difficult to keep up with the demand and every now and then And. Shortrede was called in to help, and when he failed T. Constable was engaged as late as 1841. The maroon binding was used to 1843, and then the well-known red cloth came in, which persisted to the end. The price was six shillings per volume, but somewhere in the late forties or in the fifties the price was reduced to four shillings and sixpence, which lasted until publication ceased.

An interesting note may be added. A German translation was issued at Pesth between 1836 and 1842, according to Engelmann, as follows, the first six translated by Aug. Diezmann, the last four by Friedr. Treitschke.

	Memoir	Original Date	
Vol. I.—Orn., Vol. I., Gallinaceous Birds	Aristotle	(1834)	1836
II.—Mamm., Vol. I., Lions, Tigers	Cuvier	(1834)	1836
III.—Orn., Vol. II., Game Birds	Raffles	(1835)	1836
IV.—Mamm., Vol. II., Deer	Camper	(1835)	1837
V.—Orn., Vol. III., Humming Birds I.	Linne	(1833)	1837
VI.—Mamm., Vol. III., Monkeys	Buffon	(1833)	1837
VII.—Orn., Vol. IV., Pigeons	Haller	(1835)	1839
VIII.—Entom., Vol. I., Eur. Butterflies	Merian	(1835)	1840
IX.—Entom., Vol. II., Eur. Moths	Ochsenheimer	(1836)	1841
X.—Orn., Vol. V., Parrots	Le Vaillant	(1836)	1842

It will be noted that the order is quite different from the original and that the Memoirs disagree in placement after the first six, Haller appearing in the Flycatcher volume, Pliny having been given in the Pigeon one, while Ochsenheimer is entirely novel, not being in the English List. Casey Wood was apparently unaware of Engelmann's account, as he reported the first four volumes only (? all published) with date as [? 1834-1838], but gave a biography of Hunter as appearing in his fourth volume, whereas Camper is cited in Engelmann. I have a copy in the original deep blue boards, lettered on the spine, "V. Cabinet des Thierreiches Die Colibris". The engraving of Linnaeus has the autograph, but the plates are from the first print without backgrounds and Latin names only. Other copies are in the Mathews' Library at Canberra. Apparently the project failed on the continent.

Artists.

In connection with bird books with coloured illustrations, artists' names have been commonly neglected even in the case of the large pretentious works published by the French Government. The artists were mostly very painstaking and accurate and deserve great praise, for without their assistance the works would have been much less important.

In the present case the chief artist who did the bulk of the work was James Stewart, and his illustrations and the delightful backgrounds are excellent. That he was very conscientious is shown by his action in the case of the Monkeys.

Swainson, of course, prepared his own illustrations, while Lear was called upon by Selby for the Parrots and Pigeons. Hamilton Smith, the author of the books on Dogs and Horses, was also his own artist, while Westwood painted the beautiful little Butterflies and Moths. The paintings of the Marsupials were done by W. Dickes, while a large number of illustrations have no artists' names, nor is there any comment on the matter.

Sizes and Signatures.

The sheets are of various sizes, demy, royal, imperial, folio, &c., and these are folded into four, eight, twelve, sixteen, &c. As both sides are printed upon the sheet folded into four gives eight pages, and so on. For the use of the printer the first corner of the sheet is marked with a distinguishing mark, usually the letters of the alphabet, in order, but in a series also with the volume number. These signatures occur on the first page of an octavo book, then the 17th, 33rd, 49th, 65th, &c., in duodecimo on the 1st, 25th, 49th, &c., and in a sixteenmo on the 1st, 33rd, 65th, &c., By means of these, additions or alterations in the pagination can easily be detected.

Opposition Works.

The same year in which the Naturalist's Library was started saw the production of a very similar series entitled Miscellany of Natural History, published by Fraser & Co., also in Edinburgh, and under the editorship of Sir Thomas Dick Lauder and Capt. Thomas Brown. It appeared in the same size, style of binding, &c., printed by Andrew Shortrede (who afterwards printed some volumes of Jardine's work). There were the same Publisher's Advertisement, a Memoir with a plate, and the advertisements at the back. The paintings were similar with backgrounds, and the engraving was by Joseph B. Kidd (who did some engraving for Audubon). Only two volumes appeared, the first one dealing with Parrots by Capt. Brown, at the end of 1833, the Memoir being of Audubon, while the second in 1834 dealt with the Feline Species by W. Rhind, the paintings by A. Forbes, the Memoir of Cuvier by Lauder himself. It had intended to continue, as in the Publisher's Advertisement it was announced that the co-operation of Fleming, Prof. Wilson, W. MacGillivray, Dr. Spittal and others had been arranged. The price was the same, six shillings. It should be emphasised that the originality of the Naturalist's Library was in the coloured plates, as similar small works existed, such as Constable's Miscellany, which had published a Natural History of Selborne in 1829, and Wilson's American Ornithology. This was printed by Andrew Shortreed, later Shortrede, and edited by Jamieson in four volumes in

1831-32. Perhaps the Natural History Section of Lardner's Cabinet Cyclopaedia, edited by Swainson, was brought out through the success of the Naturalist's Library. It dealt with similar subjects from 1834 to 1840, running into twelve volumes.

DATES OF ISSUE OF FIRST PRINTINGS.

	Preface	Reviewed
Vol. I.—Humming Birds	——	May, 1833
II.—Monkeys	Aug., 1833	Nov., 1833
III.—Humming Birds II.	Nov., 1833	Jan., 1834
IV.—Tigers	——	——
V.—Gallinaceous Birds	——	July, 1834
VI.—Game Birds	Dec., 1834	Feb., 1835
VII.—Perch Family	——	——
VIII.—Beetles	To be May, 1835	——
IX.—Pigeons	June, 1835	Aug., 1835
X.—British Butterflies	Oct., 1835	Dec., 1835
XI.—Deer	Dec., 1835	Jan., 1836
XII.—Goats, Sheep	——	——
XIII.—Elephants	——	——
XIV.—British Moths	——	——
XV.—Parrots	——	Oct., 1836
XVI.—Whales	——	Jan., 1837
XVII.—Birds W. Africa I.	——	May 8, 1837
XVIII.—Foreign Butterflies	June, 1837	——
XIX.—Birds W. Africa II.		Sept., 1837
XX.—British Birds I.	Dec., 1837	Feb., 1838
XXI.—Flycatchers	——	May 19, 1838
XXII.—British Quadrupeds	——	——
XXIII.—Amphibious Carnivora	Dec., 1838	——
XXIV.—British Birds II.	Sept., 1839	——
XXV.—Dogs I.	1839	Feb., 1840
XXVI.—Bees	——	May, 1840
XXVII.—Fishes	——	——
XXVIII.—Dogs II.	——	——
XXIX.—Introd. Entomology	——	——
XXX.—Marsupials	——	Sept., 1840*
XXXI.—Horses	——	Oct., 1840*
XXXII.—Fishes of Guiana I.	July, 1841	——
XXXIII.—Exotic Moths	Nov., 1841	Feb., 1842
XXXIV.—British Birds III.	Mch., 1842	——
XXXV.—Introd. to Mammalia	Dec., 1842	Jan., 1843
XXXVI.—Sun Birds	Dec., 1842	——
XXXVII.—British Fishes I.	——	——
XXXVIII.—Fishes of Guiana II.	Apl., 1843	——
XXXIX.—British Fishes II.	July, 1843	——
XL.—British Birds IV.	July, 1843	——

Some may consider that this is "Much Ado About Nothing", but many of the Monographs were original, such as the Parrots, Pigeons, Flycatchers, Fishes of Guiana, Marsupials, &c., and are of vital importance.

Coues, the greatest Ornithological Bibliographer, wrote, "Bibliography is a necessary nuisance and horrible drudgery that no mere drudge could perform. It takes a sort of inspired idiot to be a good bibliographer."

In preparing these notes I have often thought that Coues was indulgent in the use of the adjective "*inspired*".

* Although the review of Horses appeared in Oct., 1840, and Marsupials, Sept., the publisher announces that Horses appeared first.

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THE SPRAT (Stolephorus gracilis) IN AUSTRALIA

Mr. A. Fraser, Superintendent of Fisheries in Western Australia, recently sent to The Australian Museum a number of Sprats which had been netted abundantly in May, 1951, in the Houtman Abrolhos Islands. Earlier, Dr. D. L. Serventy had submitted others from north-east of the Coral Patches, Abrolhos (Approx. Lat. 28°52′ S. by Long. 114°3′ E.), which had been obtained by Mr. H. Piesse from the stomach of a Tuna (*Kishinoella tonggol*) on 14th April, 1949. Twenty years before, Messrs. M. Ward and W. Boardman collected the same species at North-West Islet, Queensland.

I identify these Sprats as *Stolephorus gracilis* (Temminck & Schlegel), originally described from Japan. This species is widely distributed (see Weber & Beaufort, Fish. Indo-Austr. Archip., ii, 1913, p. 20, fig. 12) and has been noted from Lord Howe Island, but the above are the first records from the Australian coastline, east and west, of what may prove to be a good commercial fish.

G. P. WHITLEY.

FIELD NOTES ON SOME INSECTS OF THE MOUNT KOSCIUSKO AREA.

By KEITH C. McKEOWN, F.R.Z.S.

Assistant Curator of Insects, Australian Museum.

(Plate xlii.)

The accompanying field notes are the result of a Reconnaissance Natural History Survey of the southern half of the Kosciusko National Park, in January and February, 1946, of which I was a member. This survey was organised by the Joint Advisory Committee appointed by the Linnean Society of New South Wales and the Royal Zoological Society of New South Wales, and included scientists from the Australian Museum, University of Sydney and the Botanic Gardens.

Publication of these notes has been deferred in the hope that opportunity would occur to gather further data on species discussed here, and notes on other insects occurring in the area, on which little or no information is available. Since no further opportunity for observation has presented itself, I feel that the present notes are of sufficient interest for issue without further delay. Those on the Alpine Cicada (*Tettigarcta crinita*), alone, considerably extend our previous knowledge of the species.

The ALPINE CICADA (*Tettigarcta crinita* Dist.)

This remarkable insect, previously unknown to me in life, was first met with in the vicinity of Cascade Hut, at an elevation of 4,850 feet. Usually rare in collection, little was known concerning the habits of this species—the only relevant notes being those by Howard Ashton (*Proc. Roy. Soc. Vic.*, xxxvi. (N.S.), 2, 1924, p. 238). He states that:—

"Whilst visiting Mount Kosciusko in February, I found emerging a specimen of Cicada, which, from the shape of the nymph, I took to be the Gippsland hairy Cicada, not previously recorded in New South Wales. Upon taking it to the hotel, several specimens flew into the room in which I had it, possibly attracted, as some insects are known to be, by emanations of scent which attract the opposite sex. Three were taken in this manner, either in the dusk of the evening or before dawn.

"I concluded that the species could not be uncommon in the district, and set out to find it. I was successful in taking seven specimens, most of them females, in their natural habitat. The pupae emerge upon the "Snow Gums" and stunted "Mountain Ash" of the district. The Cicada, instead of perching on the bare stems of trees and rejoicing in the sunlight, would appear to be nocturnal, for I only saw the insects fly in the dusk, and all the specimens I took were under the bark of trees, hiding like moths". J. G. Myers (Insect Singers, 1929, p. 142) amplifies this account by stating that it is found "at an elevation of 5,000 feet, which is still within the limits of large trees (Ashton, *in litt.*)"

Collecting at Cascade, on 1st February, 1946, was carried out in continuous heavy rain. No Cicadas were obtained, but one member of the party reported having "seen" several of an unidentified species.

At 7.30 p.m., following a clearing in the weather, a nymph, from which the adult was emerging, was found clinging to the rough bark at the base of the trunk of a large Snow Gum to the north of the hut: this proved to be *Tettigarcta crinita*. The further emergence of the imago was closely followed by the light of an electric torch for another twenty minutes, when the insect, free from the nymphal-skin, ascended the trunk for about six inches above the exuvium. Details of the emergence were throughout identical in every respect with those of other, and typical, species of Cicada. The expansion of the wings after emergence was, however, extremely rapid.

A further search was now initiated for further specimens, and 2 males and 2 females, detected in the ray of the torch, were taken as they rested on the trunks of the Snow Gums. When disturbed, the resting insects took wing without hesitation and flew rapidly away into the darkness without apparent inconvenience. This was in marked contrast to the behaviour of the insects by day, as later observed. A considerable number of the insects were freely flying about in the night. By midnight all activity seemed to have ceased and no insects were on the wing.

The following morning (2nd February, 1946), as soon as it was sufficiently light—about 4.30, a further search was made for the Cicadas, and another five specimens, including two taken *in cop.*, were secured. The insects, at this early hour, were resting openly upon the tree-trunks without any attempt at concealment under bark, as later in the day. By sunrise all the insects were concealed, and it was observed that this was always on the western side of the trunk, away from direct sunlight. Later in the day, unless hidden under large sections of bark, the insects always appeared to prefer the shady side of the tree; no Cicadas were, however, actually seen changing their position.

During the day a further eleven specimens were collected from under bark. All were sluggish, making no attempt to fly in the daylight, and could be taken easily with the fingers. Many empty nymphal-skins were found clinging to the trunks of the Snow Gums, two to three feet above the ground, and all found, over a considerable area, were removed in order, if possible, to secure data on any subsequent emergences.

In the afternoon of 2nd February, the party left Cascade for Tin Mine, but on our return, on 4th February, *Tettigarcta* was again taken. In no instance, however, was there any indication that any further emergence had taken place, in that area, at least, from which the nymphal-skins had been previously removed.

On 8th February, 1946, two further specimens of the Alpine Cicada were taken on Snow Gums in the vicinity of the hotel, at an elevation of about 5,000 feet. Here, again, there was no evidence to suggest recent emergence.

From these observations it may be concluded that *Tettigarcta crinita* is strictly nocturnal in its habits. No evidence was found of any tendency in the insects to be attracted to light; indeed, light appears to be actually repellant to them, as indicated by their concealment under bark by day and their seeking of the shaded side of the tree-trunks during daylight hours. The Cicada appears to be directly associated with the Snow Gum (*Eucalyptus pauciflora*), and the emergence holes of the nymphs were always in the near vicinity of these trees. In no instance was the insect found on Mountain Ash (*E. gigantea*), as mentioned by Ashton. The period during which emergence occurs is apparently in late January and early February, and is possibly influenced by climatic conditions; there is also evidence that the season is short, and may not last more than a couple of weeks. That mating occurs soon after emergence is suggested by the taking of a pair *in cop.* in February. I observed nothing to indicate the attraction of males to the females by scent, as suggested by Ashton, though this possibility should not be overlooked, especially as the males are not equipped with sound-producing organs, and are, in consequence, incapable of emitting calls, which are the means of bringing the sexes together in the typical Cicadas.

The nymphal-skin of *Tettigarcta crinita* is of a rich chestnut-brown colour, smooth and shining, and looks as if coated with varnish. Its appearance is very distinctive, and once associated with the species cannot easily be mistaken for that of any other. The fore-femur of the nymph of *T. crinita* is figured by J. G. Myers (Insect Singers, fig. 95, p. 119).

These archaic Cicadas, *Tettigarcta crinita* and *T. tomentosa* (the Tasmanian mountain-dwelling species) are, apart from their nocturnal habits—assuming that those of *tomentosa* are similar— extremely moth-like in appearance. The forewings are opaque and brown, and their bodies are very hairy or pilose. The newly emerged adult is a very pale silvery-grey in colour and—according to my notes made at the time—of 'ghost-like" appearance. When freshly emerged, it shows little

appearance of hairiness; this becomes apparent as the insect dries and hardens—a process which was complete, and the insect capable of flight, by dawn on the following morning. When resting beneath the flaking bark of the Snow Gum the Cicada looks extremely like one of the large wood-moths (*Trictena*). The colour of the Mt. Kosciusko specimens, while fresh, is predominantly a dark grey interspersed with brown and black.

In connection with *Tettigarcta tomentosa* F.B.W., usually regarded as a mountain species, it is worth recording here that specimens have been collected by Mr. J. R. Cunningham at Kingston Beach, Tasmania, at or little above sea-level.

I suggest the vernacular name of "Alpine Cicada" as more appropriate for *T. crinita* than that of "Hairy Cicada", as commonly used equally for *T. tomentosa,* and the character of hairiness is shared equally with the Tasmanian species.

The Mountain Grasshopper (*Acripeza reticulata* Guer.)

The life-history of this insect has been adequately described by Mr. Edith Coleman (*Vic. Nat.*, lvi., 1938-9, pp. 24-332; 119-122; 201), and her detailed and well-illustrated papers should be consulted.

On 29th January, 1946, during an excursion on foot to the summit of Mt. Kosciusko and the "Tops" area, occasional examples of female *Acripeza reticulata* were found sheltering around the bases of tussocks of Snow Grass (*Poa caespitosa*), the situation usually described as typical for this species.

While the party was camped at Dead Horse (5,190 feet), on 31st January, large unmbers of these insects were in evidence in the gathering dusk, the males flying about and perching upon the top of vegetation to emit their harsh, rattling chirp. Here the insects were associated with *Olearia stellulata.* It was noted that the males stridulated strongly at dusk, but were silent in the later hours of the night; stridulation was, however, resumed in the growing light of dawn, the insects falling silent again at sunrise. With daylight, the males disappeared, but their hiding places were not found; the females, however, sheltered by day in large numbers around the bases of the *Olearia* plants, especially where these were growing in contact with rocks, a sheltered situation apparently much sought after.

On the evening of the following day, while camped at Cascade Hut, Mountain Grasshoppers, or both sexes, were present in exceptionally large numbers on the open and untimbered area in front of the hut, where the Snow Grass was plentifully interspersed with *Leucopogon Hookeri* bushes. It was with *Leucopogon* that the insects were here definitely associated, in contrast with the *Olearia* association at Dead Horse; none was found sheltering among the Snow Grass (*Poa caespitosa*). In the fading light, hundreds of males were flying about somewhat clumsily and with trailing hindlegs, and alighting at intervals to stridulate harshly upon the tops of the *Leucopogon* and other vegetation standing above the level of the surrounding Snow Grass. An elevated situation was invariably sought by the male for stridulation—even the bark roof of the hut was used for this purpose. Females in even greater numbers were actively moving about at the bases of the *Leucopogon* bushes and over the more open ground. They were never seen to ascend the vegetation for more than a few inches. The females seemed completely indifferent to the stridulation of the males, and in no case was any apparent response observed—nor was there seen any indication of mating.

When stridulating, the male of *Acripeza* raises the tegmina and moves them briskly with a vibratory action; this movement is particularly evident at the bases of the tegmina which produces the effect of the insect rapidly "shrugging its shoulders". The body of the insect during stridulation is raised, and inclined at an angle of about seventy-five degrees to the plane on which it is resting. The note is distinctive, harsh and rattling.

Although the "warning" display of the female *Acripeza reticulata* has been frequently described, brief reference only has been made to the fact that the male, when disturbed, also displays in a very similar manner. The tegmina and wings are elevated vertically above the back, so as to expose the bright red, blue and

black bands upon the abdomen; simultaneously a bright orange-yellow "collar" is protruded behind the head—a procedure also followed by the female under similar circumstances. The long antennae, conspicuously banded with white, are rapidly vibrated. The effect of this display is distinctly "wasp-like".

Despite rain through the night at Cascade, the male grasshoppers stridulated throughout the hours of darkness in contrast to the behaviour at Dead Horse; this may have been due to the state of the weather.

As previously observed, the males disappeared at sunrise, and their places of concealment could could not be discovered; the females, on the other hand, congregated in numbers in the protection afforded by the bases of the *Leucopogon* plants; hundreds often gathered beneath one bush.

Despite the vernacular name of "Mountain Grasshopper", *Acripeza reticulata* is widely distributed in the eastern States of Australia, and is by no means confined to mountainous areas of high elevation. It was studied by Mrs. Coleman at Sorrento, Victoria, where it fed on the Ragwort (*Senecio Jacobea*): she observes that it is "more numerous in coastal areas than on the hills". I have had a specimen from White Cliffs, where it was collected some distance down the shaft of an opal mine!

WINGLESS GRASSHOPPER (*Monistria vinosa* Carl.)

Both sexes of this striking apterous *Acridiid* were found at Cascade on 1st February, 1946, in association with *Acripeza reticulata* among the clumps of *Leucopogon Hookeri,* and were seldom found far from it. Although closely observed, no facts of importance on its life-history or behaviour were obtained. Specimens taken *in cop.* indicated that this was the breeding season.

At Dead Horse (30th January, 1946) one of these grasshoppers was observed while casting its last nymphal-skin. The insect hung head-downwards from a grass stem, suspended by the claws of the tarsi of the hind-legs. The limbs were withdrawn from their sheaths very slowly, and were repeatedly flexed after withdrawal. The body seemed to descend almost by gravity, so slowly and smoothly was it withdrawn. It then rested for several minutes with only the extremity of the abdomen held by the nymphal-skin; the body was then flexed upwards until the grass-stem could be grasped and the withdrawal completed. The insect then crawled slowly away and sought shelter among the herbage.

A COCCID (*Monophlebulus* sp.) ON SNOW GUMS.

This large and striking orange and black Coccid occurred plentifully on the Snow Gum (*Eucalyptus pauciflora*) throughout the lower levels, but did not appear to have any adverse effect on the trees. In an area of Snow Gums between Dead Horse and Cascade, where the trees were slowly regenerating after severe bushfire injury, the young growth was literally smothered with the insects to such a degree that men and horses, forcing their way through the growth, were soon covered with the white waxy secretion of the massed Coccids. That these Coccids were having a very injurious effect upon the regenerating trees was strongly apparent.

Specimens submitted to Mr. E. H. Zeck, of the Department of Agriculture, New South Wales, were placed in the genus *Manophlebulus,* but specific identification was not possible.

SAWFLIES (*Perga lewisi* Westw.) AND SNOW GUMS.

Associated with the Coccid (*Monophlebulus* sp.), mentioned above, on the regenerating Snow Gums between Dead Horse and Cascade were very large numbers of the larvae of the reddish-brown sawfly (*Perga lewisi*), which were causing severe defoliation. Adult females of this sawfly were clinging to the foliage, staunchly guarding their newly deposited eggs, embedded in the leaf-tissue. The larvae of at least two other sawfly species were associated with *lewisi,* but their identification was not possible.

Larvae of Case Moth (*Plutorectis caespitosae* Oke.) Destroying Snow Grass.

While on the Mt. Kosciusko area, at the request of the Trustees of the Kosciusko State Park, I made an inspection of several localities where the Snow Grass (*Poa caespitosa*) was being destroyed by the larvae of a species of Case Moth (family Psychidae). This moth was subsequently described and named *Plutorectis caespitosae* by Mr. C. Oke, of Melbourne. The largest of these areas, on Pounds Creek, was visited on 8th February, 1946; it covered many acres. The larvae, each enclosed in its portable case to which grass-stems were thickly attached, abounded everywhere, eating the grass close to the ground, and leaving the upper portion to wither and die. On the affected areas, which were strikingly separated by a clear line of demarcation from the surrounding, undamaged pasture, the severed Snow Grass could could be lifted up in great sheets or "mats". Destruction of the vegetative part of the grass was complete in the infested areas, all being yellowed with no green blades showing anywhere. The Nankeen Kestrel (*Falco cenchroides*) was numerous, and ejected pellets, containing the indigestible matter from the cases of the larvae, were found plentifully on and around the areas of infestation, showing that these birds were contributing in no small degree towards the control of the pest.

Since my visit, I understand that seasonal damage by these insects has increased in some localities, and infestation has been found in pasture at Bombala, New South Wales.

A second species of pasture-destroying case moth, *Plutorectis capnaea* Turner, occurs in the Victorian Alps, where its habits are similar to that described above.

While this paper was in the press, an important contribution, "Notes on the Snow Lease Section of Hume Catchment Area", by R. T. Morland, appeared (*Journ. Soil Conservation Service of N.S.W.*, vii., Jan., 1951, 1, pp. 5-29). In this paper he states that the areas of Snow Grass attacked by the case moths do not regenerate, and subsequent infestations occur around the perimeter, steadily enlarging the area of destruction. The damage caused by these insects is a major contributing factor in the initiation of soil erosion.

Other notes discuss the effect of the saw-fly infestation on the regenerating Snow Gums.

EXPLANATION OF PLATE xlii.

Fig. 1.—The Alpine Cicada (*Tettigarcta crinita* Dist.)—female.
Fig. 2.—The habitat of the Alpine Cicada—Snow Gums at Cascade, where the insects were studied.

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NOTES ON THE BIOLOGY OF AN AUSTRALIAN TRIGONALID WASP

(*Taeniogonalos heterodoxus* Raym.)

By N. W. RODD.

(Plates xxxviii.-xxxix.)

In the course of investigation of the life histories of some Victorian saw-flies, Raff (1934) recorded the emergence of *Trigonalys maculatus* from the pupal cases of a Victorian saw-fly. Evidence secured from critical examination of the cocoon contents left no doubt that the Trigonalid larvae had been primary parasites on the saw-fly larvae.

The writer's observations on another Australian Trigonalid have yielded further proof of the association thus indicated and, in addition, it has been possible to confirm some findings of overseas works in relation to the egg-laying habits of these anomalous wasps.

At Lane Cove, near Sydney, the rocky slopes of a sandstone gully had been cleared of heavy timber and, within a year, the area was again sparsly covered with clumps of regenerating sapling comprising a number of Eucalypt Gum (*E. haemastoma*), Sydney Peppermint (*E. piperita*) and two "apple gums", *Angophora lanceolata* and *A. intermedia*. Such a concentration of tender young foliage provided ideal feeding grounds for a large population of saw-fly larvae. The Sydney Peppermints were particularly favoured by one species of such larvae and few clumps had escaped their ravages.

One warm day during the latter half of April, 1946, a medium-sized reddish-brown wasp of distinctive appearance was noticed on a young Peppermint leaf several feet above ground level. The first sweep of the net failed to secure this insect, which surprisingly remained in its original position, firmly gripping the edge of the leaf. At the second attempt capture was effected and the wasp was recognised without difficulty as a Trigonalid female which was subsequently determined by Rayment (1948) as a new species, *Taenigonalos heterodoxus*. It seemed reasonable to postulate that apparent fearlessness had been due to preoccupation with egg-laying, and the presence of saw-fly larvae was clearly significant in the light of Raff's earlier findings.

Diligent and intensive search of the locality during the remainder of April was rewarded by discovery of two further females and the process of oviposition was witnessed on numerous occasions. Invariably the young foliage of the Peppermint saplings was selected for reception of the eggs and without exception, also saw-fly larvae were present on these trees. Taking a firm stand on the upper surface, and with head facing towards the median rib, the recurved tip of the abdomen was passed under the edge of the leaf for a few seconds. This operation was often repeated many times at different positions on the perimeter of a single leaf. Subsequent examination of such a leaf revealed a corresponding number of minute lesions in the under-surface tissue, and, at high magnification, it was perceived that these represented gouges" made by the abdominal tip. In the shallow cavity thus formed a single egg had been deposited and was now visible as an eliptical white speck against the darker background of ruptured cellular tissue (plate xxxviii). The enormous fecundity of the Trigonalid family has been well attested by Bugnion and other observers (1940), and the Lane Cove species was certainly no exception to the rule. When the weather was propitious ((i.e., warm and sunny) egg-laying continued with only occasional short pauses for four or five hours per day. Average rate of oviposition during this period was in the region of ten per minute, and it can therefore be accepted that between two and three thousand eggs would be deposited in a single day.

During the corresponding few weeks of the following year study of the wasps was resumed and an attempt was made to secure further details of their

biology. However, dissection of a large series of saw-fly grubs taken from foliage heavily inoculated with Trigonalid eggs failed to reveal early instar larvae and eorts to breed out the adult saw-flies were also unsuccessful.

In 1948 again a large number of saw-fly larvae which had already entered the soil in an outdoor breeding tub were drowned by an unexpected rainfall. Many of them were recovered and dissected, but, once again, presence of parasitic larvae could not be detected.

Owing to change of address, the writer has now been obliged to discontinue his research in this most interesting field, but it is hoped to carry it to a more satisfactory conclusion at a later date.

In the meantime, however, we are left with little doubt that saw-fly larvae are, indeed, the natural hosts of *T. heterodoxus* Raym., but that successful completion of the life cycle is vouchsafed to only a very small proportion of deposited eggs. This is clearly indicated by consideration of rarity of adult wasps in relation to the thousands of eggs laid by each female.

Males of *T. heterodoxus* are very much rarer than the females, and only one example was secured during three years of intensive search of the type locality. This allotype specimen was taken whilst flying around a sapling, on the leaves of which a female was busily engaged in oviposition.

With regard to the manner in which the larval parasite enters the host's body, there is no reason to doubt that the process as described by Clausen * is also essentially applicable to the species in question.

The microtype eggs are ovoid in form and measure 0.12 to 0.15 mm. by 0.05 to 0.07 mm. The ventral surface is flat and unpatterned, whilst the dorsal is convex and patterned with an irregular system of interconnecting ridges (see plates xxxviii. and xxxix.); the number of main longitudinal ridges appears to vary between six and eight. It was noted that eggs removed from the leaf tissue and mounted in water for microscopic examination exhibited a considerable increase in volume, presumably due to osmotic transfer. This increase was accompanied by a "ballooning" of the originally flat ventral surface and the embryo frequently flowed into the sac thus formed (see Plate xxxviii., Fig. 5). It is suggested that the elasticity of the chorion in this area may serve a purpose in reducing embryonic mortality during mastication of the eggs by saw-fly larvae.

The curiously opposed ventral segments of the female wasps are actually extremely functional in design. From a consideration of fig. 2 it can readily be appreciated that the action of incising the leaf surface and also the subsequent act of oviposition must be greatly facilitated by possession of the structure in question. Its primary purpose is probably to provide a means of gripping and steadying the leaf rim prior to oviposition. However, it would also seem that judgment of depth of incision in leaf under-surfaces must also be rendered more accurate by the possession of what amounts to a pair of calipers, i.e., the spatulate extension of sternite 2 pressing against the upper surface of the leaf and resisting the upthrust terminal spear point of sternite 6. (See plate xxxviii.)

The ovipositor itself is practically vestigial and serves merely to place the eggs in the leaf incisions. The latter are preformed by action of the chitinized abdominal plate. As would be expected, the wasp is quite incapable of inflicting injury by stinging. This was proved beyond doubt by actual tests with captured specimens.

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* Having noted that the eggs of **Pseudogonalys** spp. consistently failed to hatch when left undisturbed on foliage, Clausen proved experimentally that hatching resulted "from the cracking of the chorion by the mandibles of lepidopterous caterpillars followed by the stimulating effect of the digestive juices". These observations were later verified when "several first instar larvae of **P. maga** were found within the body of a sawfly larva collected in an area where the species was known to occur".

Mr. Tarlton Rayment has kindly contributed the following description of the male allotype:—

Family TRIGONALIDAE.

Taeniogonalos heterodoxus Raym.

(Australian Zoologist, Vol. II., Part 3, p. 241, pl. xix., 1948.)

Allotype, male: Length, 10 mm. approx. Black, with yellow markings.

Head circular from the front; face-marks two yellow equilateral triangles, the base resting on the orbital margins, the apex enclosing the base of the scapes; frons and vertex with excessively large, coarse punctures, reddish; clypeus with two large yellow marks laterally, with smaller punctures; the well-developed processes covering the articulation of the scapes have the appearance of tegulae, and give a porrect appearance to the clypeus; compound eyes small, the ocelli low on the frons and close together (they are very widely spaced on Orrysid wasps); labrum yellowish; mandibulae yellow, with a black margin, the right one quadridentate, the left tridentate; these are very conspicuous structures; antennae excessively long, ferruginous, the apical segments acute, filiform.

Prothorax conspicuous, with a large yellow spot laterally; tubercles black; the collar is developed laterally, so that it ends in large tegulae; mesothorax excessively coarsely punctured, two short, wide yellow bars at the parapsidal ridges, rugose; scutellum large, coarsely punctured, some reddish laterally, a few pale hairs; postscutellum with a yellow mark laterally; metathorax large, rugose, a longitudinal median suture; abdominal segments simple, without the peculiar development of the female sterna, a yellow mark basally and laterally on the three apical segments which are obscurely reddish; ventral and dorsal segments all closely and coarsely punctured.

Legs reddish, the bases of the femora and all the coxae black; tarsi reddish; claws reddish; hind calcar reddish, finely serrated; tegulae redish, with a black mark; wings with a dark cloud filling the radial cell and extending along the costal margin; nercures brownish; cells: the first cubital failing to reach the third, as in the female; pterostigma large and amber; hamuli nine, strongly developed.

Locality: Lane Cove, New South Wales, 6th March, 1948. Norman W. Rodd.

Allotype in the collection of the author.

Allies: These anomalous wasps are not close to any described species.

I am indebted to the collector for the male, which appears to be rare, since N. W. Rodd was able to collect many females. In the figures in the "Zoologist" the maxillary palpi are too stout, for they could not be examined critically on the type. However, this is corrected by the note on p. 254, where the measurements of the segments are given.

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EXPLANATION OF PLATES.

PLATE xxxviii.

1. Immature leaf of *Eucalyptus piperita* (under-surface), showing incisions made by *T. heterodoxus* Raym.
2. Illustrating manner in which recurved tip of abdomen is brought into contact with under-surface of leaf.
3. Highly magnified section of leaf under-surface, showing lesions with eggs in situ.
4. Dorsal surface of egg (highly magnified), showing irregular ridged pattern.
5. Ventral view of egg (by transmitted light), showing embryo.
6. Side elevation of egg.

PLATE xxxix.

1. Ovipositor of *T. heterodoxus* Raym. (X50).
2. Egg in situ in leaf tissue (X50).
3. Same egg more highly magnified (X207).
4. Isolated egg (X207).
5. Isolated egg, mounted in water, showing extrusion of ventral surface due to osmotic pressure (X207).

SOME OBSERVATIONS ON THE BIOLOGY OF STEPHANIDAE AND MEGALYRIDAE (HYMENOPTERA).

By N. W. Rodd.

(Plates xl.-xli., text-figs. 1-4.)

In an authoritative treatise on entomophagous insects published during the last decade our knowledge of the Stephanidae is summarised in less than three lines of print. In the same work (Clausen, 1940) the unique Australian "long-tailed" Megalyridae do not even receive passing mention and, so far as I have been able to determine, the oviposition of neither group has yet been recorded.
Cheeseman (1932) gives a delightful account of her observations on a Melanesian Stephanid, but fails to substantiate her theory that these wasps prey upon the larvae of leaf-cutting or "carpenter" bees.

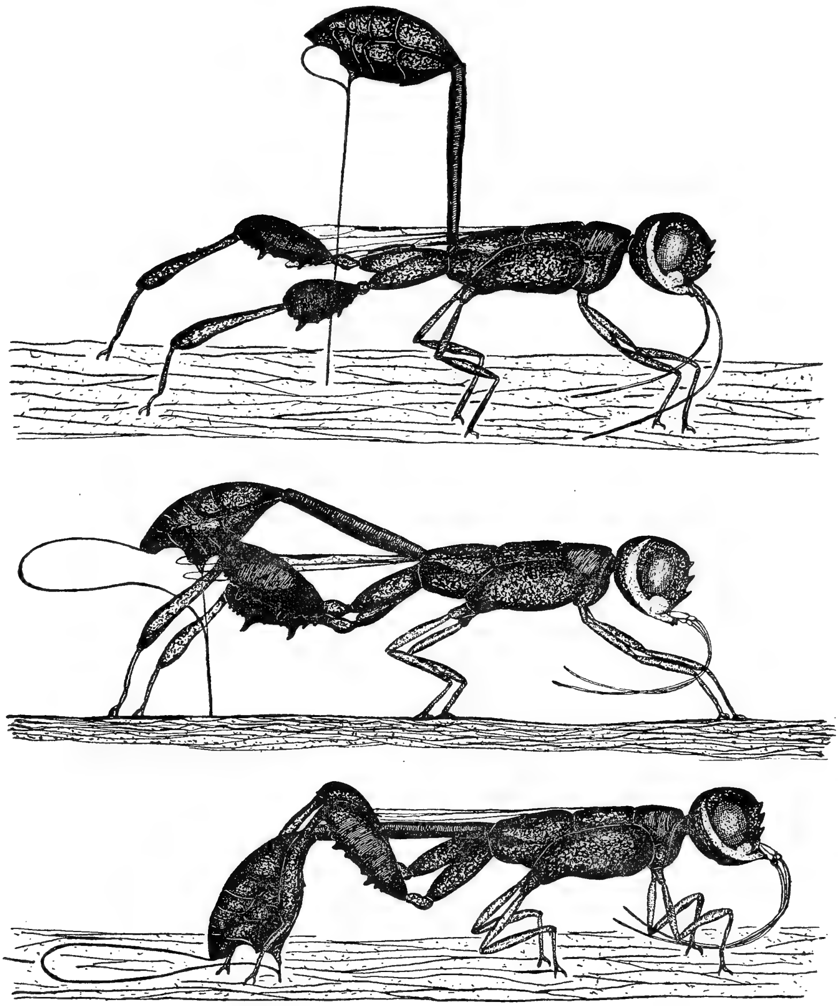
Whereas the bizarre Stephanids are of fairly widespread distribution, the Megalyridae, which are conspicuous because of their amazingly attenuated ovipositors, are purely Australian insects; factors common to both groups are their membership of the super-family Inchneumonoidea and their comparative rareness. The latter factor no doubt largely accounts for the paucity of recorded information on their respective life histories and, it is felt, justifies publication of the following notes, however incomplete they may be:—

Family Stephanidae.

At Lane Cove, near Sydney, I was able to make numerous observations of the oviposition methods of a medium-sized but as yet undetermined species of this family. Activity extended over the period November-February, and the locus operandi comprised the trunk and branches of a Sydney Red Gum (*Angophora lanceolata*) which had been felled some twelve months previously and now lay sprawled across the steep hillside of a sandstone gully. The bark had sloughed, completely leaving the naked timber which already bore plain evidence of infestation by beetle larvae.

The presence of the latter must have proved a strong attractant for the jet black Stephanids, and it was not uncommon to find several specimens scattered over the branches and main trunks when the weather was propitious. Females usually predominated, and, when stimulated by the warm sunshine, they were all intent on oviposition. Preliminaries consisted of methodical exploration of likely areas with the aid of vibrating antennae. When the presence of a suitably placed host was detected the wasp's actions became noticeably more excited and its sensory powers brought into full play. The exact position for insertion of ovipositor was finally "memorised" by circling a selected area and constantly sensing the surface with vibrant antennae. Here let it be stressed that, apart from occasional exit holes of larvae galleries, the surface of the dead Angophora was sound and quite free of visible cracks or crevies. Moreover, the timber itself was tough and springy without any external manifestations of decay. It was invariably through such a medium that the ovipositor was forced in order to reach the underlying host galleries. Also, without fail, it was observed that activity was confined only to the downward-facing surfaces of the trunk and limbs; the upper surfaces were strictly avoided. The reason for this preference may, perhaps, have been related to location of host population, but I believe that the chief motive was avoidance of exposed positions with attendant danger of sudden death from predatory birds and small lizards.

The act of forcing the slender ovipositor through the fibrous timber was often of considerable duration. On occasions, up to 150 minutes were required for the operation, and it was never accomplished in less than 20 minutes. Time required was no doubt dependent upon the distance of the host gallery beneath the surface and also upon the texture of timber to be penetrated.



Figs. 1-3: Three stages in typical drilling operations of a Stephanid.

Text-figures 1, 2 and 3 illustrate three stages in a typical drilling operation, and it will be noted that full advantage is taken of the apparently bizarre proportions of the wasp's body. In particular it is shown that the long wedge-shaped first segment functions as a fulcrum for the remaining segments of the abdomen and also as a derrick for bringing the long ovipositor into a position at right angles to the surface of the wood. Not less amazing than the feat of directing the hair-fine egg tube through several millimetres of sound wood was the apparent ease with which the same instrument was smoothly withdrawn following completion of oviposition. This operation occupied no more than a few seconds, and it was observed that the naked stylet was then freed of wood-dust by combing through the hind legs and finally re-enclosed in the grooved sheaths by a similar combing action.

For future reference several oviposition areas were carefully noted, and the underlying timber was later pared away with the aid of a stout blade, which

required to be kept sharpened to shear through the tough, springy fibres. However, it transpired that the host grubs had invariably travelled some distance after parasitisation and no evidence of the deed was to be found in the immediate vicinity of the marked area. Indeed, I was not sufficiently fortunate on any occasion to secure examples of the parasite in its early instars, although several fully developed larvae were found, together with chitinous remains of hosts. It is therefore not certain whether the early stages are endo—or ectoparasitic, although it is logical to assume the former; passage of the host grub through close-fitting galleries would surely preclude external feeding of the developing larva.

Examination of host remains revealed that they had been Bostrychid larvae of which large numbers were encountered during the search. In some cases it appeared that the beetle grub had developed fully before succumbing to the parasite, as the remains were found in typical ovoid pupal chambers at the ends of galleries.

Stephanid larvae taken from the timber early in autumn assumed pupal form during the following September and rapidly pigmented to emerge as fully developed imagos during November-December. In the case of female pupae, ovipositors were directed backwards and parallel to the dorsal surface of the body. (Plate xl.)

In confirmation of the Lane Cove observations, a number of examples of the same species of Stephanid were secured at Fraser Park, N.S.W., where they were similarly engaged in egg-laying operations on the surface of a felled Angophora. Here, again, infestation by Bostrychid beetles was in evidence and the condition of the timber was virtually identical with that of the Lane Cove tree.

Hymenopterists will be intrigued to note that the same tree at Fraser Park yielded examples of two other rare wasps, viz., *Megalyra* sp. and *Oryssus* sp. Observations on the family Oryssidae will form the subject matter of a future paper, and Mr. Tarlton Rayment has, in MS., specific descriptions of two Oryssids taken by the writer. However, the experience of thus having available for study three of the most elusive members of the Hymenopteran fauna was surely unique, and it was natural to spculate upon the antiquity of the association between such archaic representatives of Australian insect and plant societies.

Family MEGALYRIDAE.

The mechanics of oviposition by wasps of this family have long been a subject of conjecture among naturalists and, indeed, it is not possible to regard a female Megalyrid without giving some thought to the problem. From a consideration of the non-rigid nature of the egg-tube it has at various times been surmised that penetration of sound timber thereby would be impossible. On the other hand, it has been conclusively demonstrated in Wild Life (1949) that the larvae of these wasps prey upon the wood-boring larvae of some of our larger beetles and moths. To the best of my knowledge, however, the larval form of *Megalyra* has not yet been recorded and evidence of host identity has been rather fortuitously assembled from occasional chance discoveries of "broods" of fully developed wasps in association with chitinous host remains.

On a mid-October day in 1947 a hot, dry, westerly wind blew over the sandstone ridges and gullies and, with the thermometer hovering in the nineties, I chanced upon *Megalyra* and was fortunate in witnessing the manner in which the astonishingly long and slender ovipositor is brought into contact with the concealed host. A dead Blackbutt (*Eucalyptus pilularis*) tree stood on the top of a ridge at Cowan (near Broken Bay, N.S.W.), and the remnants of its dark fibrous bark still hung rigidly in thick sheets. The bared surface of the trunk was decorated with a maze of winding frass-filled galleries which provided clear evidence of recent attacks by wood-boring larvae. A large female M. *fasciipennis* was observed systematically exporing this attractive territory, and her vibrating antennae eventually located what she sought. Her attention became centred upon a conspicuous frass-plug several feet above ground level and she spent some minutes in thoroughly familiarising herself with its location in relation to the surrounding surface.

Finally, she turned away from the plug and moved upwards along the trunk for a distance equal to the length of body plus ovipositor (i.e., approx. 3 inches). At about half this distance a hanging piece of bark was encountered and had to be surmounted, thus adding to the difficulty of placing herself in the correct position with relation to the frass plug. However, the task was accomplished, and the slightly arched ovipositor was directed down towards its objective. (Plate xli.)

As the ovipositor tube was slowly forced into the granular plug the sheaths soon became detached and were tossed around like pennants by the gusty wind.

At high magnification it is to be observed that the dorsal surface of the ovipositor immediately behind the tip bears a series of transversely arched ridges, constituting ineffect a very beautiful rasp. Judicious use of this rasp no doubt greatly assists in the clearing of a passage through the mass of tightly packed wood particles and serves to relieve friction on the great length of ovipositor which follows.

On this particular occasion the ovipositor was only inserted to about half its length before reaching its objective. Intense rhythmic contraction of the abdomen was observed at this stage, and this was undoubtedly a manifestation of the effort of forcing eggs through the long, fine duct of the ovipositor. The operation now completed, withdrawal of the ovipositor was effected and, at this stage, the insect was captured for reference.

A hundred yards down the ridge a second female was observed on another dead tree. In this instance external evidence of borer infestation was not very apparent, but the dry timber had split in places and provided means of access to the underlying sap wood. In a narrow crack thus formed the wasp was seen to insert her ovipositor full length, but the position was too high above ground level to permit the operation to be observed in detail. Nevertheless, I was left in no doubt that *Megalyra* sometimes uses this means for effecting oviposition upon hosts which would otherwise be protected by an impenetrable thickness of sound timber.

The sequel to these observations was diappointing. It had been hoped to sceure larval stages of the parasite from the frass-plugged gallery of the Blackbutt tree. However, on returning for this purpose a few weeks later, only a stump was found as evidence of an axeman's labours, and any grubs, if they had survived, were irretrievably lost in a backyard woodheap.

The larval history of the long-tailed wasps thus remained obscure, and it was not until December, 1950, that a further opportunity presented itself to gain some knowledge of the early life of the Megalyridae.

It was at Tallong, on the southern highlands of N.S.W., that I was able to observe the oviposition of one of the smaller members of the family and was subsequently successful in securing a mature larva together with remains of its host. On this occasion the operation of ovipositor insertion was performed in the dead timber of a standing Eucalypt (species undetermined) located on the upper slopes of the Shoalhaven River Gorge, and at an altitude of approx. 1,900 feet. Although some earlier "borer" activity was evidenced by a few unplugged gallery entrances, the general surface of the trunk was of sound texture, but minutely decorated with a pattern of more or less convoluted ridges. The area selected was carefully and systematically re-surveyed with vibrating antennae, and the sensory impression thus gained was then apparently used in directing the ovipositor tip to the position judged most suitable for commencement of "drilling". Finally, a successful entry was effected and the visible length of the ovipositor slowly lessened. Due to the toughness of the timber and the apparent absence of any assistance in the form of cracks, etc., the operation was of long duration. Actually ninety minutes elapsed before the tube was inserted to its full length, and, shortly thereafter, it was withdrawn and cleaned. The posture of the wasp during the latter operation was rather extraordinary, as she literally lay on her side on the vertical surface of the tree trunk and used the free hind leg to comb the surface of the ovipositor. Several days later a careful dissection of the timber in the immediate and near vicinity of the oviposition centre resulted in the discovery of a fully developed Hymenopteran larva which was occupying the pupal chamber of a

small beetle's larva. Of the latter, only the chitinised head and portion of the epidermis remained. The wasp larva was rather elongated (8.5 x 1.7 mm.), but otherwise of typical Ichneumonoid form. By reason of its proximity to the Megalyrid's observed egg-laying activities it was reasonable to assume a direct relationship and subsequent development of the larva has demonstrated the correctness of this conjecture.

On the 28th December (i.e., five days after removal from the wood) metamorphosis occurred. The pupal form was such as to leave no doubts of its identity as a Megalyrid, but the absence of ovipositor indicated that this specimen was a male. This was rather disappointing, as I would have welcomed the opportunity of observing the manner of disposition of the long appendage during the pupal state.

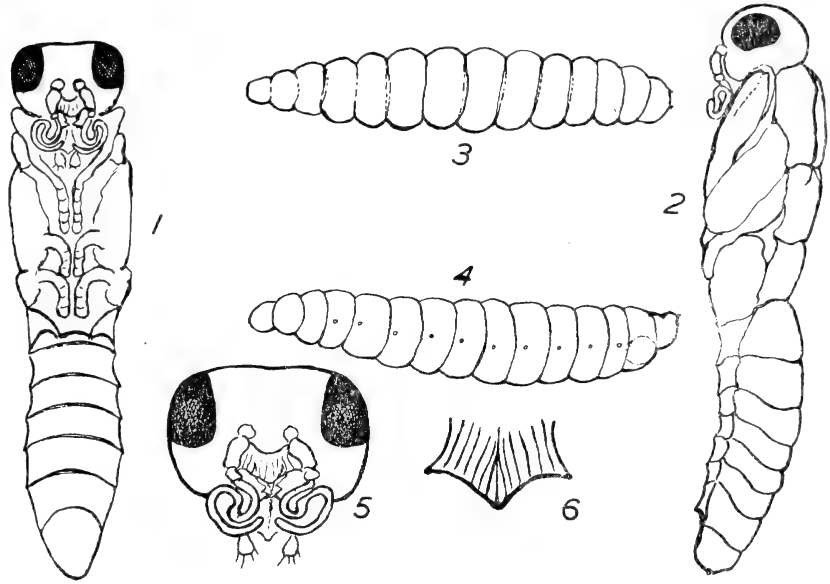


Fig. 4: Biology of Megalyridae.

1. Pupa of male—ventral view.
2. Lateral view.
3. Last instar larva—dorsal view.
5. Head of pupa enlarged to show coiled arrangement of antennae.
6. Pupal clypeus (greatly magnified).

Pigmentation of the compound eyes commenced within three days of pupal ecdysis and proceeded rapidly thereafter. By the 23rd January pigmentation was practically complete, and a week later the legs were fully developed and capable of vigorous movement. Unfortunately, the conditions could not have been suitable to permit complete shedding of exceedingly thin and closely adhering pupal "skin" and this, in turn, prevented final development of the wings.

A peculiar feature of the pupal morphology was the manner in which the developing antennae were compactly looped in the form of the two flat coils. (See text-fig. 4.)

Since completing these notes my attention has been drawn to a short paper by Gray (1947) in which are recorded some observations on Megalyrid egg-laying.

The method of ovipositor manipulation appears to have been similar to that observed by the writer, but it is difficult to interpret satisfactorily Gray's claim that the tube is inserted into "minute holes" in the timber's surface. However, as the holes were in fence posts, it is possible that the wasps were actually ovipositing in galleries which had been exposed during dressing of the original logs.

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Wild Life, XI., 10 (1949), pp. 463-464.

EXPLANATION OF PLATES.

PLATE xl.

1. Ventral view of Stephanid pupa—male.
2. Lateral view of Stephanid pupa—female.
3. Ventral view of fully developed larva.
4. Lateral view.
5. Scape and portion of flagellum of adult Stephanid.
6. Tip of ovipositor showing slightly barbed surface.
7. Tip of ovipositor sheath.
8. Labial palp of female.
9. Maxillary palp.
10. Anterior wing of adult Stephanid.
11. The hamuli are few in number and of very weak construction.
12. The tarsal claws are mono-denate.

PLATE xli.

1. Adult *Megalyra fasciipennis*—female. Only small portion of ovipositor shown.
2. Illustrating position adopted for insertion of ovipositor in frass plug. Commencement of operation.
3. The beautifully constructed rasp just behind the ovipositor tip.
4. Portion of anterior wing showing weak hamuli.
5. Basal segments of antenna. Note curved first segment of flagellum.
6. Maxillary palp.
7. Labial palp.
8. The tarsal claws are monodentate.

RECENT PALAEONTOLOGY.

By Tom Iredale.

Bather, in his Presidential Address to the Geological Section of the British Association for the Advancement of Science in 1920, discussed the relations of the palaeontologist and the neontologist, showing how each must supplement the other in the unravelling of evolutionary secrets. He was dealing with his own familiar Echinodermata, but drew examples from every other class, especially stressing the time-concept on classification as opposed to the neontologists' scheme of static forms. Unfortunately, as he well understood, the very imperfect geological record induced as much error in the time usage as the neontologist did in his static arrangements. Probably the skilled neontologist recognises the fallacies in his system, but has not received help from the palaeontologist, who has commonly regarded the neontologists' work as unintelligible and not applicable. However, Bather realised that the recent advances in neontologists' methods might tend to solve some of the palaeontologists' problems and that "an organism should be studied in relation to the whole of its environment".

Molluscs probably react more rapidly to environmental stresses than members of most other classes, and as their external skeletons are well preserved palaeontological subjects, they can be cited as worthy examples for intensive study. After discussing the many changes recognised by palaeontologists, Bather concluded, "To correlate the succession of living forms with all these changes is the task of the palaeontologist. To attempt it he will need the aid of every kind of biologist, every kind of geologist".

I have long maintained that the marine mollusca of the Tertiaries of Southern Australia are so closely bound up with the living species that their study must be carried out by the close co-operation of the palaeontologist with an experienced neontologist (conchologist). At present the palaeontologist rarely asks the assistance of the neontologist, although many of his troubles might be obviated by such reference.

Herewith are presented some examples that have come under my notice with indications of their manner of solution:—

Largs, near Newcastle, New South Wales.

From a series of raised beaches, a large number of mollusca was collected and reported upon some sixty years ago. The specimens were of recent facies, so were submitted to J. Brazier, the well-known conchologist, at that date. Thirty-two species were separated and named as follows:—*Ostrea angasi, O. subtrigona, Pecten strangei, P. asperrimus, P. tegula, Mytilus hirsutus, M. menkeanus* var., *Scapharca gubernaculum, Chama spinosa, Tellina deltoidalis, Corbula scaphoides, Spisula cretacea, Tapes turgida, Chione isabella, C. lamellata, Dosinia sculpta, Venus* (*Timoclea*) sp., *Clementia papyracea, Fusus hanleyi, Nassa livida, N. jonasi, Natica conica, N. plumbea, Monilea lentiginosa, Calliostoma decoratum, Euchelus atratus, Triton costata, T. pilearis, Risella lutea, Lampania australis, Potamides ebeninus, Trochocochlea multicarinata* (and *Balanus trigonus*, barnacle). To-day this collection shows mixture of shells from rocky foreshores, sandy shores and estuarine waters with muddy influence, almost exactly paralleling a collection from an estuarine water with outside overflow. The collection was reported as above in the Records of the Geological Survey of N.S.W., Vol. II., p. 48, 1890, and the specimens should be in the Survey's possession. This collection was duplicated by Hedley in 1916 and housed in the Australian Museum, Regd. Nos. C.40749 et seq., 32 species in all. The coincidence in the number of species is exact, but not exactly the same species were collected. Those added by Hedley were:—*Pecten medius, Salacia jacksoni, Venerupis crenata, Standella nicobarica, Codakia pisidium, Arcularia peritrema, Leucotina concinna, Mathilda* sp., *Turbonilla* sp. and *Dentalium* sp. There is nothing in these additions to alter the above conclusion. The

late H. S. Mort showed me a small collection that came into his possession labelled, "From Largs, near Maitland. At the depth of twelve feet from the surface occurs an ancient sea beach. From this bed these marine shells were taken". There were about eleven species obviously of the same series.

The species which attract attention are *Pecten strangei, Mytilus menkeanus* var. (Hedley called it M. *erosus*) and *Euchelus atratus*. The first named has since turned up in Sydney Harbour dredgings, while *Euchelus atratus* (a common tropical shell) has been found on the shores of northern New South Wales. But the other has defied relationship and is here named *Antetrichomya problematica* gen. et sp. nov. to keep the problem under review. It was recorded as *menkeanus* and then as *erosus,* both natives of southern Australian, but it seems to have no close relationship with them. It bears a much more deceptive resemblance to the Neozelanic *maorianus,* but has the inner edge crenulate throughout, thus widely separating it. In this feature it agrees with *Trichomya* and the hinge can be compared also with the hinge of that genus. The shell, however, is much larger, more strongly ribbed, stouter, the hinge having a large elongated narrow tooth, whereas *Trichomya* is edentulous. The shape is very like that of *T. hirsuta,* the ventral surface being sinuately incurved, the dorsal angle acute, but the posterior dorsal margin flattened: the sculpture consists of about twenty thickened ribs posteriorly diverging to over forty. The ventral area is similarly sculptured, but the ribs are very much thinner and almost obsolete medially, almost suggesting a smooth area. The size is very large, the largest (type) being broken posteriorly, yet measuring 90 mm., with a height of 50 mm. *Antetrichomya* is nothing much like *erosus* in shape, but has similar heavy sculpture, while it lacks the boss seen on the anterior muscle-scar, an easy recognition mark of *erosus*. The hinge, of course, differs.

All the specimens discussed in this paper are in the Australian Museum.

Bather suggested a time-concept genus; that is, the fossil representatives that could be arranged successionally should be considered a genus, and not the present series that appear similar, but may have a distinct lineage series. This is excellent in a Utopian collection which shows the lineage completely, but this occurs so rarely that as much guesswork would be needed in the formation of lineage series as there is in the present usage of similarity species. In mollusca these lineage series can be suggested by the study of recent forms, but only rarely can the facts be determined. Years ago I indicated that the relationship between the recent marine mollusca of Southern Australia and the fossils in the Victorian beds was extremely close, and that lineage series should be worked out. However, before this could be successfully performed much novel stratigraphical study must be undertaken and new collections in accordance with the stratigraphical results made, and then these should be critically examined by a neontologist before any results were published as to their affinities.

The form above described appears to be an indirect ancestor of the recent *Trichomya hirsuta* and both appear in the collections. This suggests that the collection is not pure; that is, from the same horizon, and that the fossil ancestor was found in a lower zone. *Trichomya hirsuta* occurs between tides from Southern Australia to North Queensland without any useful variation, congregating in large masses. Such associations suggest casualties, and in kitchen middens above the sea-level in Middle Harbour, Sydney, shells of this species abound, though at present no living specimens exist anywhere near the locality.

TOMAGO SANDBED BORINGS.

Mr. Ivor Callen, of the Hunter Water Board, submitted some samples from borings made in this district, north of Newcastle, New South Wales. Many species of shells were picked out of the different borings with stated depths, and the results were so interesting that confirmation was desired, but the boring was too expensive to be carried out for the mere satisfaction of the scientist. It seems best to put these on record, as the chance of confirmation is now more remote.

The shallowest boring submitted was some thirty feet down, and all the shells were common estuarine forms with no puzzling species at all present. This was what would have been expected, but a few feet below the majority of the species

were those found on the sea beaches, odd estuarine shells being noted as derivative. Farther down still fewer estuarine shells were noted and these were very worn and broken, while corals were present.

Detailed lists were made up of the species present in each boring sample, but it is unnecessary to give these here. The main species indicating the association may be noted thus: In the highest section *Arca trapezia, Pyrazus ebeninus* and *australis, Natica conica, Amesodesma, Thalotia comtessi, Notospisula producta, Parcanassa jonasi,* etc., all very common estuarine dwelling forms. In the next lower, specimens of these were rarely noted, while the Glycymerids, especially *holosericus,* were abundant; *Mactra caloundra, Tentidonax nitida, Strigilla euronia, Zenatiopsis victoriae* and similar common seashore inhabitants characterised the boring. In the lowest boring a few broken estuarine shells occurred, then some of the shore shells above mentioned, and then *Periglypta, Chlamys, Fragum, Gomphina* of Queensland facies and not yet recognised in New South Wales waters. The lesson from these borings is that the Tomago area was at one time, not very distant, a basin of the open sea, and that it filled up little by little until the last phase was estuarine. At a very recent date it became landlocked and dried up as it appears to-day. It is possible that the later stages were contemporary with the familiar Largs deposits and that the very early stages yet unknown might coincide with the era of the strange Largs mussel, previously discussed.

The whole coast of Eastern Australia from Bass Straits to Rockhampton is an area of inland bays and estuarine lakes. Their study has not yet been undertaken, but promises a rich return. While so many inlets and lagoons show on the map, this does not in any way suggest the Tomago sandbeds as the base of an inlet unless by a vivid stretch of imagination Port Stephens were linked with the Hunter River.

As to the succeeding Lismore episode, reading the map does not give the slightest suggestion of an estuarine inland lagoon in that vicinity. It may be noted that Moreton Bay comes into the eastern system as reclamation spoil there agrees very closely with similar spoil from Sydney Harbour. The littoral Marine Mollusca of Moreton Bay have also a basic Sydney Harbour facies, but it is now adding a large proportion of tropical shells, so that while the Mollusca Fauna of Sydney is one of the largest in the world (perhaps reaching 2,000 species), that of Moreton Bay may exceed it when that area has been worked as intensively as its more southern rival.

LISMORE.

The Town Clerk of Lismore submitted some shell fragments from an excavation near the town some fifty miles from the sea for consideration as to whether they were being found in situ or were part of a kitchen midden. Obviously they were not the latter, but the occurrence was so unusual that more material was requested to determine exactly the facts, and this was immediately furnished with notes as to the deposits depth. The ground level was about twenty-eight feet above sea level at which the shells were found. The overlay for the first twelve feet was pug, followed by eight feet of brown clay, then four feet of blue clay, then four feet of black sand, below which were five and a half feet of compressed pug. The common Sydney Cockle, *Arca trapezia,* was abundant, while a few *Notospisula parva,* small *Nassarius,* such as *burchardi* and *peritrema, Pyrazus australis* and *Ostrea angasi,* were present. With these, however, were northern shells hitherto unrecorded from New South Wales, and these constituted the problem. The most striking was the Window Pane Shell, and it was very numerous; with it were some *Pitarina, "Paphia hiantina"* and *Nassarius lividus* and some broken minute species of little consequence. The Window Pane Shells are very well known as being the predecessor of glass in eastern countries, and are apparently still in use. Five well-marked forms are commonly known, of which the Saddle, *ephippium,* may be dismissed, as its saddle shape makes it useless as a window pane, and it does not need comparison. The other four are all allotted to the genus *Placuna,* and may be separated by their shape and teeth divergence. Two are orbicular and two are irregular and all are very thin and flattened. *Placuna placenta,* the typical Window Pane Shell of China, is very thin, orbicular,

with two teeth of unequal length placed close together. *P. lincolnii*, described from Australia, is similar in shape, or little thicker, with two subequal teeth, widely divergent. *P. papyracea* (or *quadrangularis*), described from Tranquebar, India, has an irregular shape, the hinge line broader than the ventral edge, but has small subequal divergent teeth, while *P. lobata*, first seen from Port Essington, North Australia, has an irregular shape with a broad hinge line, but with the ventral edge lobed, exceeding the hinge line in width with subequal divergent teeth. The shells from Lismore belong to *P. lincolnii*, but curiously enough they are very large, with the teeth less spread than the northern form, so may be given a subspecific name *P. lincolnii ulterior*, the type measuring 165 mm. in breadth by 158 mm. in height. Included was a single specimen of *P. lobata*, easily recognisable, and only measuring 79 mm. in breadth by 68 mm. in height.

The valves of "*Paphia hiantina*" were large, equalling the Western Australian type, and larger than most of the Queensland shells hitherto collected. The *Pitarina* seems to be the same as *osmunda*, which was named from Sydney Harbour dredgings, and which may still live on the Northern Coast of New South Wales.

Consequently, the *Placuna*, which occurred abundantly, is the only shell demanding investigation, as its occurrence suggests that the sea reached inland to Lismore in comparatively recent times and that there was a huge basin open to the sea, which gradually filled in, and that the *Placuna* represents an earlier age than the Sydney Cockle.

NEW NAMES.

Two new molluscs have been named:—

Antetrichomya problematica, gen. et sp. nov., from Largs, N.S.W.; and and *Placuna lincolnii ulterior*, subsp. nov., from Lismore, N.S.W.

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REVISION OF THE NEW SOUTH WALES CERITHIOPSIDAE.

By Charles F. Laseron, F.R.Z.S.

(Plates xxxv.-xxxvii. and text figure.)

Introduction.

Few families have presented as many difficulties as the Cerithiopsidae. The main difficulty has been in obtaining adequate material for study. The animals are not gregarious, and living specimens are found individually and at wide intervals. Beach material is generally quite inadequate. The species resemble each other so closely that the slightest wear obliterates the essential characters. This applies particularly to the protoconch, the absence of which nearly always precludes specific determination. The material on which this paper is based has been gradually accumulated in over 20 years' collecting, and only now is it felt possible to present something like a comprehensive picture of the group. This does not mean that the list of species is yet complete, and it is probable that many others exist, particularly on rocky reefs in depths up to 30 fathoms off the coast. This is probably the main habitat of the group. A glimpse of a diverse and largely unknown molluscan fauna was obtained in two small but fortunate dredgings, one in a gap between reefs in 14 fathoms off Long Reef, near Sydney, the other in 10 fathoms off Point Halliday, on the North Coast. Both dredgings contained a number of specimens of *Cerithiopsis* divisible into several species, all different from those found on the foreshores. A more recent dredging by my son John in 8 fathoms at the mouth of the George's River from a sandy mud bottom also yielded an unusual number of specimens, all dead, but many in good condition with the protoconchs intact. These were divisible into six species. It is surmised that these had lived on algae on the neighbouring sea bottom. The few living specimens found on the foreshores have been found in ones or twos on algae, generally below low tide. A few specimens have also been found living under rocks in pools, and occasional beach specimens have been found in sufficiently good preservation to be identified.

In spite of its diversity very little work has yet been done locally on the group. In Hedley's Check-List (1918) three species of *Cerithiopsis* and four of *Seila* are listed. Of the *Cerithiopsis, cacuminatus* was described from a broken specimen from very deep water, and this has not since been rediscovered. Of the four species of *Seila, halligani* is another from very deep water, *albosutura* is of very doubtful identification, and *turritelliformis* is of quite a different group, for which Iredale (1924) proposed the genus *Seilarex.*

In Tasmania, where there is generally a close affinity with the New South Wales molluscan fauna, May (1921) listed seven species under *Cerithiopsis.* None of these can yet be positively identified with any New South Wales species. Hedley included *C. cessicus* in the New South Wales list, but this is here separated under the name *Joculator hedleyi.* Of the other Tasmanian species, *C. semilaevis* of Tenison-Woods is alone likely to cause confusion. The type was from a single specimen in the National Museum, Melbourne, from north-west Tasmania. It was unfigured and the description was so brief that it can here be quoted in full: Shell minute, turreted, pale chestnut, complexly latticed with keels and ribs, whorls 12, the apical 5 smooth". The only distinctive character given is the 5-whorled protoconch, but as several species occur in New South Wales with similar protoconchs, it is impossible to say if any is conspecific. In view of the type locality, however, the probability is not great.

The four Tasmanian species of *Seila* listed by May are the same as those listed by Hedley for New South Wales and do not call for special comment. How far their identification is correct it is impossible to say, and it is quite possible that some future revision will be necessary.

The present paper adds greatly to the number of local species. In all nearly 40 species are discussed, and it has been found necessary to describe many

as new species. Some criticism may therefore be anticipated. It would seem strange that such a wealth of new material has been for so long overlooked, but it may be that the difficulty presented by worn specimens has caused workers to sidestep the group. To date there has been very little systematic collecting. Even the Australian Museum collection, so rich in other ways, is peculiarly deficient in this material. A couple of tubes presented by the late Charles Hedley are labelled *Bittium* sp., and contain several species of *Cerithiopsis*. These are, however, very worn and lack their protoconchs. The labelled specimens of *Cerithiopsis angasi* and *Seila purpurea* also lack protoconchs, and might belong to any of several species. This criticism is not derogatory, for the field is so large and the workers so few, that it is inevitable that individual groups should be overlooked, particularly when specific differences are small and difficult to elucidate. Hedley found the same position arise with the Triphoras and Iredale with the Epitoniums.

Acknowledgments: My chief acknowledgment for assistance is to my son John, with whom the collection has been mutually made. Again and again, when sorting out dredgings or washings from sea-weeds, it has been his keen eye that has detected the elusive specimen of *Cerithiopsis,* and without his assistance very little of the material would have come to light. Miss Joyce Allan, Conchologist to the Australian Museum, as usual, put the resources of the Museum at my disposal, but most of the work has had to be pioneering, and must still be open for further revision.

All types, as well as specimens illustrated, have been presented to the Australian Museum, where they will be kept intact as a basis for future classification.

CLASSIFICATION.

It is unfortunate that little data can here be given to throw light on the ultimate genetic relationship of the local species. The operculum is an important feature of the Cerithiopsidae as distinct from the Cerithiidae, and has been described as paucispiral with a sub-lateral nucleus. Specimens, though collected alive with other material, have been picked out some time after when the operculum has been too far retracted to study, and specimens have never been abundant enough to break for the purpose of recovering it.

This point would have had to be left in abeyance were it not that David McAlpine, a brilliant young collector, has succeeded in separating the operculum of a species he found crawling on the underside of rocks below low tide at Bronte, near Sydney. This species has been named *Cerithiopsis macalpinei* later in this paper. The operculum is thin, paucispiral, the nucleus sub-marginal and close to the anterior end. (See fig. 40.) This corresponds very well with the European Cerithiopsidae and confirms the relationship of the Australian species. David McAlpine also sketched the animal, but it was unfortunately so small that it could only be studied from the underside, and all its external characters were not visible. The foot is fairly long and narrow, the eyes at the base of the tentacles, and the proboscis so small as to be invisible or more probably retractile. Comparing this with the local common Bittium, *Cacozeliana* * *lacertina,* the smaller form living on the outside reefs, the Bittium animal has a strong, broad proboscis which it does not retract. This Bittium also has a round operculum, with a central nucleus, but only a few broad whorls. (See fig. 41.)

Of taxonomic characters the protoconch is considered the most important. It is taken as an axiom that where the protoconch is different, even though other shell characters are apparently similar, different species are indicated. The phrase apparently similar is used deliberately, for where the protoconch is found to be different, other small but constant differences are invariably found. The protoconch of the Cerithiopsidae varies much in detail. It may have one whorl, two, three, four, five or as many as seven whorls. It may be smooth and glassy, or it may be sculptured. It may be separated by a slight varix, or it may merge gradually into the mature shell. One feature all the protoconchs have in common: the initial whorl is at an angle and is more or less infolded. Angas in his descriptions of both *Cerithiopsis angasi* and *Seila purpurea* speaks of it as sinistral, but I think

* **Cacozeliana** Strand replaces **Cacozelia** Iredale, preocc.

this is wrong, as in the great many specimens examined no trace of sinistral twisting has been detected, certainly nothing like the heterotrophe protoconchs of the Pyramidellidae.

Colour has been found a very constant character. Many of the species are uniformly brown or red brown, but where a deeper subsutural band occurs, or where there is any colour variation at all, it has been found very useful for specific recognition. In *Cerithiopsis* and *Seila* the aperture is useful for separation from the local Bittiums and other Cerithiidae. The columella is broad and flat and more or less truncate and partially hides the short and somewhat twisted canal which is often invisible from in front. The spiral sculpture also stops at the periphery of the body whorl, which mainly has an excavate base.

The New South Wales species are here discussed under six generic names. These would seem to be fairly natural groups with characters sufficiently defined to allow of ready separation. The following key may be useful for their determination:—

KEY TO GENERA.

(a) Sculpture 3 to 4 spiral keels broken into rounded tubercles.

1. Spire elongate with straight sides. Base excavate. *Cerithiopsis.*
2. Spire short and convex, base with an extra keel. *Joculator.*
3. Spire elongate with straight sides, keels 4, columella strongly bent. *Pilaflexis.*

(b) Sculpture 3 spiral keels, only slightly indented, canal prolonged, columella twisted. *Binda.*

(c) Sculpture 3 to 4 smooth spiral keels, minute transverse striae in the furrows between.

(a) Whorls rounded, sutures deeply indented, thin secondary spirals between the main ones. *Seilarex.*

(b) Whorls flat, sutures barely distinguishable.

1. Spire flat, base smooth and excavate. *Seila.*
2. Spire convex, base sculptured. *Paraseila.*

DESCRIPTION OF SPECIES.

Genus CERITHIOPSIS Forbes and Hanley, 1853.

The genus *Cerithiopsis* is here limited to elongate shells with flat spires, the sutures not deeply indented. The sculpture consists of three or sometimes four spiral keels, broken into tubercles. The base is excavate and smooth. Anterior canal short and broad, partially hidden behind the columella, which consists of a short, broad plate, often truncate in front. Outer margin of aperture thin.

In view of the great number of species proposed, the following key to the New South Wales species, based on the number of whorls in the protoconch, may be useful in future identification. The number of whorls is exclusive of the small infolded nuclear whorl.

(a) Protoconch with 7 whorls, smooth.
C. septapilia.
(b) Protoconch with 5 whorls, smooth.
C. quinquepilia, C. exigua, C. literalis.
(c) Protoconch with 4 whorls, smooth.
C. macalpini, C. filofusca, C. alternata, C. georgensis.
(d) Protoconch with 3 whorls, smooth.
C. tripilia, C. exilis, C. virgula.
(e) Protoconch with 2 whorls, smooth.
C. clava, C. gregaria.
(f) Protoconch with 1 whorl, smooth.
C. jacksonensis, C. quadrispiralis, C. angasi.
(g) Protoconch sculptured.
C. crassa, C. hebes.

(h) Full protoconch not yet determined.
C. cancellata, C. infracolor, C. bicarinata, C. cylindrica.

Cerithiopsis jacksonensis, sp. nov. (Figs. 1, 1a.)

Shell of medium size for the genus, deep red brown, conical, rather broad, spire even. Protoconch small, 1 whorl, plus the infolded nucleus, white and glassy. Mature whorls 7, increasing regularly, very slightly rounded, sutures slightly indented. The first mature whorl with indefinite transverse sculpture, on the remainder, three prominent, rounded keels, wider than the spaces between, a fourth keel on the periphery of the body whorl. Transverse sculpture also prominent, consisting of strong ribs, about 16 on the body whorl, continuous between the keels, and breaking the keels into tubercles which are inclined to be rectangular. Base smoth and excavate. Aperture sub-rectangular, outer margin thin and rounded, columella short, broad and rounded in front, canal short, hidden by the columella. Length 4.7 mm.

Locality: North Harbour, Port Jackson.

Remarks: The very small, short protoconch and rather broad form are good recognition points. It is related to *C. angasi,* but is smaller, there are fewer tubercles to the whorl, the tubercles are larger and more angular, and the shape of the columella differs.

Cerithiopsis quadrispiralis, sp. nov. (Figs. 2, 2a.)

Shell of medium size, yellow brown to deep red brown, elongated conical, spire even. Protoconch small, of one whorl, plus the infolded nucleus, white and glassy. Mature whorls 8, increasing regularly, rounded, restricted at the sutures. Sculpture on the first mature whorl faint, remaining whorls with four spiral keels, in width about equal to the spaces between, with a fifth keel on the periphery of the body whorl. Transverse sculpture consisting of fairly prominent ribs, about 24 to the whorl, nearly obsolete between the keels, but breaking the keels into small, rather irregular tubercles. The base excavate, nearly smooth, but with traces of the transverse sculpture. Aperture ovate, outer margin thin and rounded, columella short, rather narrow and slightly bent, canal short, visible from in front. Length 4.6 mm.

Locality: Yamba (2 specimens).

Remarks: This may be compared with *C. alternata,* which it resembles by the rounded whorls and restricted sutures. It differs, however, in the protoconch, and also differs from most New South Wales species by having four keels.

Cerithiopsis cylindrica Watson.

Hedley's Check-List, 1918, No. 564. (*Bittium.*)

I have been unable to identify any of the local species with Watson's species. His figure is good and his description very full, and the type locality is from 2-10 fathoms, Port Jackson. Points taken from the original description which should aid recognition are:—Height 0.27 inches, width 0.064 inches; apex blunt, rounded, slightly oblique and a little immersed; spire high, narrow, pointed, with short but slightly angulated, contour lines; whorls 13, costae about 25 on last whorl, pillar straight, not short, pretty strong, with a rounded, narrow, twisted edge, and a small but not sharp point, which is very slightly rounded; furrow between the keels about equal to the width of the keels.

The blunt, short apex alone restricts comparison with very few species, all of which are shorter and rather broader. Watson's figure shows a narrow pillar, and the aperture would fit the shell here called *C. gregaria,* though *gregaria* has a broader, shorter shell, and a small, glassy protoconch. Though described as a *Bittium,* the excavate base suggests *Cerithiopsis,* but until its rediscovery this point must be left in abeyance.

Cerithiopsis gregaria, sp. nov. (Figs. 3, 3a.)

Shell of medium size, red brown fading to grey, conical, rather broad, spire even. Protoconch small, of 2 whorls, white and glassy, plus the infolded nucleus. Mature whorls 8, increasing regularly, very slightly rounded, sutures slightly

indented. Spiral sculpture prominent, consisting of three, rather narrow, sharp keels, with wider spaces between, and a fourth keel on the periphery of the body whorl. Transverse sculpture also prominent, consisting of numerous ribs, about 24 on the body whorl, narrow, distinct between the keels, and breaking the keels into small, well-elevated, sharp tubercles. Base smooth and excavate. Aperture rather elongate, outer margin rounded and thin, columella thin and narrow, tapering to a point anteriorly, canal short and visible from in front. Length 4.5 mm.

Locality: Exceedingly abundant on the reclamations, The Spit, Port Jackson, associated with *Bittium grenarium* and *B. icarus.*

Remarks: This is very doubtfully referred to *Cerithiopsis,* and it may well be a *Bittium.* The excavate base, separating it from the associated species of *Bittium,* suggests *Cerithiopsis,* but on the other hand, its apparently gregarious habit and the narrow columella separate it from all the other *Cerithiopsis* here discussed. Its exact generic position must therefore still be in doubt.

Cerithiopsis angasi Semper. (Fig. 4.)

Hedley's Check-List, 1918, No. 571.

Originally described by Angas as *C. clathrata,* this name was found to be preoccupied, and Semper renamed the species *angasi* in 1874.

The type came from dredgings on the Sow and Pigs Reef, and it has been difficult to decide which of the numerous species it is. Angas could hardly have anticipated the complexity of the group; hence both his figure and description are hardly complete enough for specific determination. Points taken from his description which fit the specimen here figured are are the rounded whorls with indented sutures and the rather elongated tubercles, which number about 25 on the body whorl. Angas speaks of the nuclear whorl as sinistral, a character he also gives to *Cerithiopsis* (*Seila*) *purpurea.* I think this is a mistake, as the initial whorl in every species of both *Cerithiopsis* and *Seila* examined is infolded and nothing like the heterotrophe protoconchs of the Pyramidellidae. As he makes no reference to other smooth whorls of the protoconch, it is presumed that the protoconch of *angasi* is short and like that here figured. Traces of sculpture appear even on the first visible whorl. Other points to be noted are the fifth keel on the body whorl, the base hardly excavate, and the columella, which is rather pointed and very slightly bent back. The specimen figured is 6.5 mm. long and was collected at Kurnell.

Cerithiopsis tripilia, sp. nov. (Fig. 5.)

Shell large for the group, long and turreted, stout, colour yellow brown. Protoconch moderately stout, continuing the line of the spire, of three whorls, plus the infolded, the next two smooth, glassy and yellow brown, incipient sculpture appearing on the third. Mature whorls 8, increasing regularly, short, slightly rounded, restricted at the sutures. Sculpture consisting of three regularly spaced, equal, rounded keels, with a fourth on the periphery of the body whorl. The transverse sculpture consists of numerous, straight ribs, about 35 on the body whorl, which cross the keels and break them into very small, rounded tubercles. On the later whorls incipient new keels appear between the main ones, so that the transverse ribs are broken into two rows of smaller tubercles. Base smooth and excavate. Aperture subquadrate, outer lip thin, columella short and truncate, its anterior margin sloping, canal behind the columella, invisible from in front. Length 7 mm.

Locality: North Harbour, Port Jackson.

Remarks: This species, with *C. alternata* and *C. bicarinata,* forms a small group with indented sutures and secondary keels appearing between the main ones. *C. alternata* has a four-whorled protoconch and is only half the size, and *C. bicarinata* has cancellate sculpture and a different columella.

Cerithiopsis clava, sp. nov. (Figs. 6, 6a.)

Shell of moderate size, elongated conical, thick at the summit with a wide apical angle, stout, colour bright, pale yellow. Protoconch thick, of 2 whorls, plus the infolded nucleus, at first sight smooth, but microscopically with faint, radial sculpture. Mature whorls 8, nearly flat, not restricted at the sutures. Sculp-

ture consisting of three prominent, rounded subequal keels, separated by narrow, deep and well-defined channels, a fourth keel on the periphery of the body whorl. Base smooth and excavate. The transverse sculpture consists of numerous straight ribs, about 27 on the body whorl, barely visible in the channels, but breaking the keels into prominent, rounded tubercles. Aperture subquadrate, outer margin thin, columella slightly bent, short and wide, rounded anteriorly, canal short, behind the columella and invisible from in front. Length 4.6 mm.

Locality: 14 fathoms off Long Reef (2 specimens).

This may be compared with *C. crassa* and *C. hebes*, both of which have sculptured protoconchs. To the eye *C. clava* has a smooth protoconch and has thus been placed in section (e) of the Key, but it is also readily separated from both *crassa* and *hebes* by the sharp, narrow furrows between the keels, and also by other details of the sculpture and columella.

Cerithiopsis crassa, sp. nov. (Figs. 7, 7a.)

Shell of medium size, conical, spire even, colour yellow brown. Protoconch blunt, nucleus infolded, next whorl at first smooth, then incipient sculpture appears. Mature whorls 7, increasing regularly, very slightly rounded, sutures slightly indented and distinct. Sculpture consisting of three, subequal keels, separated by channels of about the same width, a fourth keel on the periphery of the body whorl. Transverse sculpture strong, consisting of prominent ribs, about 16 on the body whorl, contracted between the keels, and rising into rounded tubercles where they cross. Base smooth and excavate. Aperture short, subquadrate, outer margin straight and thin, columella short and broad, obliquely rounded anteriorly, canal short, hidden by the columella. Length 3.6 mm.

Locality: Ocean Beach, Manly.

Remarks: This may be grouped by the protoconch with both *C. clava* and *C. hebes*, but differs from both by the fewer and stronger transverse ribs.

Cerithiopsis hebes, sp. nov. (Figs. 8, 8a.)

Shell small, conical, broad, spire even, colour red-brown. Protoconch blunt, the nucleus infolded, the next two whorls with faint transverse sculpture. Mature whorls 6, increasing regularly, flat, sutures barely indented, but distinct. The spiral sculpture consists of three prominent, subequal keels, separated by channels of about the same width, a fourth keel on the periphery of the body whorl. The transverse sculpture is barely visible between the keels, but breaks them into rather irregular, rounded tubercles, about 24 on the body whorl. Base excavate and smooth. Aperture short, subquadrate, outer margin thin, columella short, broad and truncate, canal short, hidden by the columella. Length 3.8 mm.

Locality: 8-10 fathoms off Point Halliday (3 specimens).

Remarks: The blunt, sculptured protoconch is a good recognition point. Comparison has already been made with the species *C. clava* and *C. crassa*.

Cerithiopsis filofusca, sp. nov. (Figs. 9, 9a.)

Shell of moderate size, cylindro-conical, colour pale yellow buff with a narrow golden brown thread at the sutures. Protoconch slender, of 4 whorls, plus the infolded nucleus, remainder smooth and glassy. Mature whorls 8, very slightly rounded, sutures slightly restricted. The spiral sculpture consist of three prominent, rounded keels, the centre one the most prominent, separated by slightly narrower channels. The transverse ribs are nearly obsolete where they cross the channels, but break the keel into rounded tubercles, about 18 on the body whorl. A fourth keel appears on the periphery of the body whorl and is coloured golden brown, and it is the overlapping of this keel by the earlier whorls which produces the coloured band at the sutures. Base smooth and excavate. Aperture subquadrate, outer margin thin, columella short and broad, subacuminate anteriorly, curved on the inner margin. Canal short, hidden by the columella, in immature specimens longer and slightly twisted. Length 5 mm.

Locality: 14 fathoms off Long Reef (3 specimens).

Remarks: The golden band at the sutures and below the body whorl is a good recognition point. This is the first of a number of species with long glassy

protoconchs of many whorls. In separating the species not only is the number of whorls important, but their relative length, and their apical angle in relation to the apical angle of the mature shell.

Cerithiopsis quinquepilia, sp. nov. (Figs. 10, 10a.)

Shell of medium size, conical, spire even, colour yellow brown. Protoconch slender, of 5 whorls plus an infolded nucleus, smooth, white and glassy. Mature whorls 7, increasing regularly, very slightly rounded, and slightly restricted at the sutures. The spiral sculpture consists of three subequal keels, the centre slightly the largest, all prominent, rounded, in width about equal to the furrows between. A fourth keel on the periphery of the body whorl. The transverse ribs are fairly prominent, about 18 on the body whorl, overriding the keels and breaking them into prominent, rounded tubercles. Base smooth and excavate. Aperture nearly square, short, outer margin thin, columella short, broad and straight, obliquely truncate anteriorly, canal short, behind the columella. Length 4 mm.

Locality: 14 fathoms off Long Reef (3 specimens).

Remarks: This may be grouped with *C. exigua* and *C. literalis*, and the three species are probably closely related. Compared with the other two the protoconch of *quinquepilia* is intermediate in width, broader than in *literalis* and narrower than *exigua*. The sculpture is also coarser and the columella narrower than in both these species.

Cerithiopsis cancellata, sp. nov. (Fig. 11.)

Shell rather large for the group, cylindrical, spire contracted towards the apex, colour nearly white. Protoconch incomplete in the type, only two whorls remaining, but it is probably 4 or 5 whorled, smooth and shining with short whorls. Mature whorls 9, short, increasing more rapidly at first, the later whorls nearly equal, giving a distinct facies to the spire. Whorls very slightly rounded, sutures well indented. The spiral sculpture consists of three subequal keels, rather narrower than the furrows, with a fourth keel on the body whorl overlapped by the earlier whorls. The transverse sculpture is prominent, consisting of numerous ribs, about 26 on the body whorl, which are thick and well defined in the furrows, producing a cancellation. The keels themselves are broken into small rounded tubercles by the transverse costae. Base smooth and excavate. Aperture short, outer margin rounded, columella short, broad and truncate, canal short and behind the columella. Length 5.5 mm.

Locality: Shell sand, Port Stephens.

Remarks: The spire contracted at the apex and the nearly equal later whorls give this species a distinct facies, and the cancellate sculpture is another good recognition point.

Cerithiopsis alternata, sp. nov. (Fig. 12.)

Shell of medium size, conical, spire even, colour golden yellow. Protoconch tapering in the line of the spire, of 4 whorls plus an infolded nucleus, smooth and shining, but the fourth whorl showing traces of sculpture. Mature whorls 6, increasing regularly, rounded, contracted at the sutures. The spiral sculpture consists of 7 keels of two orders, three principle keels, narrow but prominent, with the secondary small thin keels alternating between them. Both series are overridden by the transverse ribs, about 26 on the body whorl, and broken into low, rather elongate tubercles. An extra keel appears on the body whorl. Base smooth and excavate. Aperture comparatively large, outer margin rounded, inner margin straight, columella rather longer than usual, narrower and anteriorly rounded, canal short and broad, visible from in front. Length 3.6 mm.

Locality: Shell sand, Port Stephens.

Remarks: The two orders of spiral keels link this with *C. bicarinata* and to a lesser extent with *C. tripilia*. Differences between these species have already been discussed.

Cerithiopsis infracolor, sp. nov. (Fig. 13.)

Shell rather large, evenly conical, colour buff with a deep brown base, also brown between the keels, particularly on the later whorls. Complete protoconch

unknown, only one whorl remaining. This is white and glossy and the whole is probably 2 or 3 whorled. Mature whorls 9, increasing regularly, quite flat, sutures not indented and barely distinguishable. Spiral sculpture regular, consisting of three subequal keels, the upper keel slightly the most prominent, slightly wider than the spaces between, a fourth keel on the periphery of the body whorl. Th transverse sculpture consists of regular ribs, distinct across the furrows, and breaking the keels into regular, rounded tubercles, about 20 to the whorl. Base excavate and smooth. On slightly worn specimens the sculpture appears as a regular rectangular reticulation. Aperture short, outer margin thin and rounded, columella short and broad, rather pointed anteriorly, canal short, behind the columella. Length 5.4 mm.

Locality: 14 fathoms off Long Reef, a number of specimens.

Remarks: The extreme regularity of this species, the flat whorls and the deep brown base are good recognition points. It cannot be readily confused with any other species.

Cerithiopsis septapilia, sp. nov. (Fig. 14.)

Shell of medium size, conical, rather broad, spire even, colour deep red brown (type immature). Protoconch long and slender, of 7 whorls plus an infolded nucleus, paler than the mature shell, smooth and glassy. Mature whorls in immature type 5, but probably 7 or 8 in the mature shell, increasing regularly, very slightly rounded, sutures slightly indented. It is possible that later whorls may increase less rapidly to make the complete spire slightly convex. The sculpture is typical of some other species, three, prominent, subequal, rounded spiral keels, about equal in width to the furrows between, crossed by transverse ribs, about 17 to the whorl, the ribs narrowed in the furrows, but breaking the keels into prominent tubercles which tend to be rectangular in shape. Aperture short, subquadrate, outer margin thin, columella short and rather narrow, but again immature, canal short. Length 3 mm.

Localities: Under rock at Bronte (type), collected by David McAlpine; on weed, North Harbour, Port Jackson.

Remarks: Though only two immature specimens of this species have so far been recognised, it is probably not uncommon, but the extraordinary protoconch would be very easily broken, and in its absence it would be hard to distinguish it from such species as *C. literalis,* which it otherwise resembles.

Cerithiopsis, sp. (Figs. 15, 15a.)

Two specimens, one a decorticated specimen from reclamations at Bayview, Pittwater, the other an immature specimen with protoconch from Point Halliday, are evidently different from other local species, but the material is insufficient at this stage to justify a new specific name, and they are here figured for future reference. The features noted are the conical, broad shell, colour buff with brown base, rounded whorls restricted at the sutures, the large rounded tubercles on the keels, about 20 to the whorl. The aperture is immature, but comparatively large, and the shell when mature probably has 7 or 8 whorls. The protoconch has 3 whorls, plus an infolded nucleus, it continues in the line of the spire, and is smooth and glossy.

Cerithiopsis bicarinata, sp. nov. (Fig. 16.)

Shell large for the group, conical, solid, spire even, colour pale yellow. Protoconch unknown, apex of type worn. Mature whorls 10, increasing regularly, very slightly rounded, sutures indented. The spiral sculpture is of two orders, three main, rounded narrow but prominent keels, with a secondary series of much smaller keels between. The transverse sculpture is prominent, consisting of numerous rounded ribs, about 24 on the body whorl, continuous across the furrows to produce a cancellation. Where they cross the keels they break them into small tubercles, but these are not prominent. An extra keel appears on the body whorl, and the base is smooth and excavate. Aperture short, subquadrate, outer margin thin and rounded, columella broad and truncate, canal short and broad, visible from in front. Length 7 mm.

Locality: 14 fathoms off Long Reef.

Remarks: This species in its sculpture resembles *C. alternata,* but is altogether a larger and more robust shell, with much less rounded whorls. Compared with *C. tripilia,* the transverse sculpture is much stronger, dividing the channels between the keels into rectangular pits, and the columella is broader and more truncate.

Cerithiopsis macalpinei, sp. nov. (Figs. 17, 40.)

Shell small, conical, spire even, colour very deep red brown. Protoconch of 4 whorls, plus an infolded nucleus, fairly broad, continuing in the line of the spire, yellow brown, smooth and glassy. Mature whorls 6, increasing regularly, very slightly rounded, sutures well indented. Sculpture consisting of three, broad, prominent spiral keels, with a fourth on the body whorl, separated by narrow furrows. The transverse sculpture consists of prominent ribs, continuous across the furrows, about 16 on the body whorl and breaking the keels into large, rounded tubercles. Aperture large and inflated, expanding in mature shells to a thin wide outer margin free of sculpture. Base of shell smooth and excavate, the columella broad, narrowed and rounded anteriorly, canal broad and shallow, visible from in front. Operculum thin, paucispiral, the nucleus submarginal and near the anterior end. Length 3.5 mm.

Locality: Living beneath weed-covered rocks below low tide, Bronte, near Sydney. (Collected by D. McAlpine.)

Remarks: I am indebted to the brilliant young collector David McAlpine for this species, also for details of the operculum and some notes on the animal, given in the Introduction. It was at first thought to be the species I have called *C. exigua,* with which it is almost identical, but examination of a number of specimens of both species shows it to have one less whorl in the protoconch, a character taken to be conclusive. To the eye it can be separated by its much deeper colour.

Cerithiopsis georgensis, sp. nov. (Figs. 18, 18a.)

Shell comparatively large, conical and slender, spire even, colour yellow brown in the type which is probably faded, but specimens from George's River deep red brown and almost black. Protoconch slender, of 4 whorls, plus an infolded nucleus, yellow, smooth and glassy, incipient sculpture appearing gradually on the fifth whorl. Mature whorls in type 11, but more usually 8 to 9, increasing regularly, nearly flat, sutures slightly indented and distinct. Sculpture three spiral keels, rounded, in width about equal to the furrows between, broken by the transverse ribs into regular, rounded tubercles, about 22 on the body whorl. The ribs continue across the furrows as distinct, narrow ridges. Base smooth and excavate. Aperture subquadrate, outer margin rounded and thin, columella short and broad and obliquely truncate anteriorly. Canal short, hidden from in front behind the columella. Length of type 6.9 mm., usually rather shorter.

Localities: 6-9 fathoms, Sow and Pigs Reef (type); 6 fathoms, Doll's Point, George's River (abundant).

Remarks: It resembles *C. literalis,* but with one fewer whorl in the protoconch, and the protoconch is not so slender. The sculpture differs also, with more numerous, smaller and more rounded tubercles.

Cerithiopsis exigua, sp. nov. (Figs. 19, 19a.)

Shell small, conical, spire even, colour yellow brown. Protoconch of 5 whorls, but shorter and wider than in *C. quinquepilia,* yellow, smooth and glassy. Mature whorls 6, slightly rounded, sutures slightly indented. The spiral sculpture consists of three subequal, prominent, rounded keels, rather wider than the furrows between, with a fourth narrow keel on the periphery of the body whorl. The transverse ribs are strong and rounded, about 16 on the body whorl, and override the keels which are broken into prominent rounded tubercles. Base smooth and excavate. Aperture rounded, expanded, thin on outer margin, the columella short, very broad and truncate, slightly oblique anteriorly. Canal short, hidden by the columella. Length 2.7 mm.

Localities: Living on seaweed, North Harbour (type); Beach, Huskisson.

Remarks: This is very closely related to *C. quinquepilia*, so much so that their descriptions are almost identical. Each has a 5-whorled protoconch, but that of *exigua* has definitely shorter, broader whorls. The whole shell is also smaller, and though with one less whorl, the expanded aperture not only shows maturity, but gives the shell quite a different facies. Comparison may also be made with *C. literalis*.

Cerithiopsis literalis, sp. nov. (Figs. 20, 20a.)

Shell of moderate size, conical, spire initially slightly convex, colour deep yellow-brown. Protoconch long and slender, of 5 whorls, plus an infolded nucleus, white, smooth and glassy. Mature whorls 8, the earlier whorls increasing rather more rapidly than the later whorls, making the upper part of the spire slightly convex, whorls nearly flat, sutures distinct, but hardly indented. The three spiral keels are prominent, broad and rounded, much wider than the furrows between, and there is a fourth, narrow keel on the body whorl. The transverse ribs are prominent, about 17 on the body whorl, hardly visible in the furrows, but breaking the keels into very prominent tubercles which tend to be rather rectangular in shape. Base smooth and excavate. Outer margin of aperature rounded and thin, columella very short and broad, truncate, anteriorly slightly oblique, canal short, hidden by the columella. Length 5 mm.

Locality: Under rock, Castle Rock, Port Jackson.

Remarks: This again is closely allied to both *C. exigua* and *C. quinquepilia*, but differs from both by being larger, in small details of the sculpture, by the slightly convex spire, and by the very slender, elongated protoconch.

Cerithiopsis exilis, sp. nov. (Fig. 23.)

Shell minute, broadly conical, spire even, colour buff brown with brown base. Protoconch narrower than the summit of the mature shell, yellowish, smooth and glassy, of 3 whorls, plus an infolded nucleus. Mature whorls 4, increasing regu-largely, rounded, restricted at the sutures. The three spiral keels are subequal, rather narrower than the furrows between, and are broken into small, elevated tubercles, about 16 on the body whorl, by the transverse ribs which appear as narrow threads crossing the furrows. A fourth narrow keel appears on the body whorl. Base smooth and excavate. Aperture with outer margin rounded and thin, columella short, broad and slightly bent anteriorly, canal short and broad, visible from in front. Operculum just visible, thin and horny, outer margin notched to conform to the indentations of the keels, nucleus indeterminable, the only markings visible a few transverse, curved plications. Length 1.8 mm.

Locality: 30-35 fathoms off Crookhaven.

Remarks: This is the only specimen so far obtained from deeper water. By its rounded whorls it resembles *C. alternata*, which also has a similar protoconch; but *exilis* is much smaller, comparatively broader, and lacks the secondary keels between the main ones.

Cerithiopsis, sp. (Fig. 24.)

A single specimen from shell sand, Narrabeen, is probably not quite mature, and needs more material before it is specifically named. It is, however, figured and described for future reference. It is white, broadly conical, broader than any other local species. The protoconch is minute, of one whorl, plus an infolded nucleus, smooth and glassy. Mature whorls 4, rounded, restricted at the sutures. The three spiral keels are rather thin, the transverse sculpture is visible in the furrows and breaks the keels into small, rather irregular tubercles, about 24 to the whorl. Aperture large, outer margin rounded and thin, columella short and broad, obliquely truncate anteriorly, canal short, hidden by the columella. Length 2 mm.

Cerithiopsis virgula, sp. nov. (Figs. 26, 26a.)

Shell small, cylindrical, colour yellow buff, base brown. Protoconch peglike of 3 whorls, plus an infolded nucleus, the first smooth, the others with faint transverse ribs, separated by a distinct varix from the mature shell. Adult whorls 6, slightly rounded, the first much wider than the protoconch, the median whorls in-

creasing rapidly, the last three nearly equal, sutures impressed. The sculpture consists of three subequal, spiral keels, a fourth on the body whorl, about equal in width to the furrows between. The keels are crossed by transverse ribs, about 18 to the whorl, rising into rounded tubercles on the keels, and narrowed to sharp ridges in between, producing a cancellation. Base excavate and smooth. Aperture subquadrate, outer margin thin and rounded, columella flat moderately broad, straight, tapering anteriorly, canal short, behind the columella. Length 2.5 mm.

Localities: The Spit, Port Jackson (type); also from shell sand, Port Stephens.

Remarks: The narrow, peglike, sculptured protoconch, separated by a varix from the mature shell separates this from all other local species. A good recognition point also is the distinctive contour caused by the near equality of the last three whorls.

PILAFLEXIS, gen. nov.

Genotype, *Pilaflexis regularis,* sp. nov.

A genus of the Cerithiopsidae generally similar to *Cerithiopsis,* but with an extra spiral keel, the transverse sculpture not so prominent, and the columella pillar laterally strongly bent.

Pilaflexis regularis, sp. nov. (Figs. 21, 21a.)

Shell comparatively large, conical, elongate, spire even, colour buff. Protoconch of 3 whorls, plus an infolded nucleus, rather blunt, the whorls subangular, with incipient transverse sculpture. Mature whorls 12, increasing regularly, flattened, sutures however distinct. Sculpture distinctive, the spiral sculpture consisting of 4 or 5 regular, subequal keels, one sometimes reduced to a thread at the sutures. These are overridden by the transverse ribs, about 20 on the body whorl, barely discernable in the furrows, but breaking the ribs into broad, elongated, rather irregular tubercles. Base smooth and excavate. Aperture short, almost square, outer margin straight and thin, columella short and broad and bent back sharply to enclose the short, rounded canal. Length 8.5 mm.

Localities: 8-10 fathoms off Point Halliday (type); also 14 fathoms off Long Reef.

Pilaflexis oculis, sp. nov. (Figs. 22, 22a.)

Shell comparatively large, regularly conical, spire even, colour red brown. Protoconch blunt, the nucleus infolded, the faint transverse sculpture on the first whorl becoming stronger on the next. Mature whorls 9, increasing regularly, flat, sutures hardly indented, but distinct. Sculpture distinctive, consisting of four regular, subequal keels, rather narrower than the furrows between, with a fifth keel on the body whorl. The transverse sculpture is barely visible in the furrows, but breaks the keels into very elongated, lens-shaped tubercles, about 14 on the body whorl. Base excavate and smooth. Aperture short, quadrate, extended beyond the columella, outer margin straight and thin, columella short and broad, obliquely truncate and bent back to enclose the short canal. Length 6 mm.

Locality: 6 fathoms, Doll's Point, George's River, several specimens.

Remarks: The bent columella and 4 keels make this congeneric with *P. regularis,* from which it can easily be distinguished by the lens-shaped tubercles, elongated in the line of the keels.

BINDA, gen. nov.

Genotype, *Binda tasmantis,* sp. nov.

Shell acuminate, intermediate in sculpture between *Cerithiopsis* and *Seila,* the keels but slightly indented by the transverse sculpture. Base excavate, aperture quadrate, canal produced anteriorly and twisted backwards, protoconch inflated.

This is a deep-water genus, and like so many others coming to light from the Continental shelf, has a distinct facies which suggests relationship with fossil rather than with existing shore species. The curious shell named *Cerithiopsis cacuminatus* by Hedley and Petterd from an imperfect specimen probably comes here, as does the New Zealand species *Newtoniella stiria* of Webster from 110 fathoms off the Great Barrier Island. *Newtoniella* of Cossman was based on a

European Cretaceous fossil. The possibility of real genetic relationship over such a gap both in geography and time is exceedingly remote. The name *Binda* is based on an aboriginal place-name meaning deep water.

Binda tasmantis, sp. nov. (Fig. 25.)

Shell elongate and acuminate, thin and translucent, spire even, colour yellow brown with darker base. Protoconch of 2 whorls, plus an infolded nucleus, first whorl inflated, wider than the summit of the mature shell, colour white and smooth. Mature whorls 12, flat, sutures hardly indented and difficult to discern. Sculpture three, prominent, flattened, spiral keels, separated by narrow channels, with very indefinite, transverse sculpture breaking the keels into undulations rather than tubercles. Base excavate and smooth. Aperture quadrate, outer margin thin and straight, columella short and broad, twisted anteriorly, the canal broad, produced beyond the aperture and twisted. Length 8 mm.

Locality: 30-35 fathoms off Crookhaven (3 specimens).

Remarks: I know of no other species with which this can readily be compared.

Binda cacuminatus (Hedley and Petterd).

Hedley's Check-List, 1918, No. 572 (*Cerithiopsis*).

The type came from 250 fathoms east of Sydney, a distinctive species, but imperfect, with the aperture quite missing. Its slender form, dimensions and inflated 2-whorled protoconch suggest relationship with *B. tasmantis,* and it is tentatively considered congeneric. It is, however, a much more nodular shell.

Genus JOCULATOR Hedley, 1909.

Proc. Linn, Soc., N.S.W., Vol. xxxiv., 1909, p. 442.

Genotype, *Cerithiopsis ridicula* Watson.

Hedley proposed *Joculator* as a sub-genus with the following characters: "Shell small, dextral, of ovate or bulbous contour, with a smooth, subulate, many-whorled protoconch". Taking the bulbous contour as the chief characteristic of *Joculator,* several New South Wales species come well within it, but the protoconch is found to differ in some species, and is not always many-whorled. Another character is, however, noticeable, not only on the local, but also on the Queensland species, and this is the presence of a slight fold or keel on the base. The flat pillar of the columella is also often transversely striate or ribbed.

Joculator hedleyi, sp. nov. (Fig. 27.)

Shell of medium size, large for this section, grey, possibly faded, stout and barrel-shaped with convex spire. Protoconch incomplete, smooth and glassy, probably 4 or 5 whorls when complete. Mature whorls 7, increasing at first rapidly, body whorl contracted anteriorly, giving the characteristic barrel-like form. Whorls flattened, sutures hardly indented, but distinct. Sculpture three prominent, spiral keels, subequal, about equal in width to the furrows between, broken into regular, large, rather angular tubercles, about 22 to the whorl, by the transverse ribs, which are barely visible in the channels. An extra keel is on the body whorl. The base is excavate, with a faint rounded keel just above the columella. Aperture with rounded, thin, outer margin, columella short, rather pointed anteriorly, covered with a flattened plate, at an angle within the aperture, the junction of which is visible in front, canal short and broad, visible from in front. Length 4 mm.

Locality: Dredged in Middle Harbour, above the Spit, Port Jackson.

Remarks: This is probably the shell listed from Sydney as *Cerithiopsis cessicus* (Hedley's Check-List, 1918, No. 573), recorded from a single worn specimen from 8 fathoms, Sow and Pigs Reef. Hedley figured a Tasmanian specimen for future reference, which is shown as a narrower shell with fewer tubercles, and without the extra keel on the excavate base. The occurrence of the Tasmanian *cessicus* in New South Wales is still open to doubt.

Joculator minor, sp. nov. (Fig. 28.)

Shell small, barrel-shaped, inflated, red brown. Protoconch of type not complete, only 2½ whorls remaining of probably 4 or 5, smooth and white, adult

sculpture appearing suddenly, but with no apparent varix. Mature whorls 5, flattened, increasing more rapidly at first, body whorl contracted anteriorly, sutures hardly impressed but distinct. Sculpture consisting of three, prominent, subequal spiral keels, in width about equal to the furrows between, broken into prominent, rounded tubercles, about 20 on the body whorl, by the transverse ribs, which are reduced to narrow threads in the furrows. An extra keel appears on the body whorl. Base excavate with a narrow keel or fold just above the columella. Aperture short, outer margin rounded and thin, columella short and broad, wedge-shaped, canal short, just visible from in front. Length 2.1 mm.

Locality: Reclamations, Carr's Park, Botany Bay.

Remarks: Very close to *J. hedleyi* in general details, but only about half the size, and differing mainly in the details of the aperture, particularly the columella.

Joculator nanus, sp. nov. (Fig. 29.)

Shell minute, barrel-shaped, greatly inflated, colour red brown. Protoconch small, of 2 whorls, plus an infolded nucleus, white, smooth and glassy. Mature whorls 4, increasing rapidly, the body whorl contracted anteriorly, flat, sutures hardly indented but distinct. Sculpture consisting of three, subequal, prominent, rounded, spiral keels, broken by the transverse sculpture into large, rounded tubercles, about 14 on the body whorl, the transverse ribs obsolete in the furrows which are rather narrower than the keels. A fourth keel appears on the body whorl. Base excavate with a rounded keel just above columella. Aperture with thin, rounded, outer margin, columella short, broad, obliquely truncate, and with several transverse, rounded plications, canal short, visible from in front. Length 1.8 mm.

Locality: 8 fathoms, Doll's Point, George's River.

Remarks: This is the smallest of the local species also the most inflated, and in addition, can be readily distinguished by the small protoconch.

Joculator gracilis, sp. nov. (Figs. 30, 31.)

Shell small, barrel-shaped, rather elongate, colour deep red brown. Protoconch slender, rising like a spire above the summit of the mature shell, of 4 whorls, plus an infolded nucleus, yellow, smooth and glassy, sculpture appearing on the fifth whorl with no apparent varix. Mature whorls 6, nearly flat, the body whorl contracted anteriorly, sutures slightly indented and distinct. The sculpture consists of three, subequal, prominent, rounded, spiral keels, broken into prominent, rounded tubercles, about 14 on the body whorl, by the transverse ribs which are nearly obsolete in the furrows between the keels. A fourth keel appears on the body whorl, and the excavate base has another keel just above the columella. Aperture short, outer margin slightly expanded and rounded, thin, columella short and broad, obliquely truncate anteriorly, transversely striated, the inner margin thickened, canal short, visible from in front. Length 2.4 mm.

Locality: Not uncommon in 8 fathoms, Doll's Point, George's River (type); alive on seaweed, 2 fathoms, Port Hacking.

Remarks: Very like *J. nanus* in general features, but narrower, and with fewer tubercles to the whorl. The striated columella should be a useful recognition point. Fig. 31, from Port Hacking, was drawn as another species before it was concluded that it was the same as the type specimen. The columella in the figure is not quite correct, and is nearer the drawing in Fig. 30. Length 2.8 mm.

Genus SEILAREX Iredale, 1924.

Genotype, *Seila turritelliformis* Angas.

The genotype certainly stands out from other species included in *Seila* and may well be separated generically. Iredale gives no generic characters beyond stating that it differs from *Seila* in "shape, sculpture, form of mouth and texture of shell". This may be supplemented by saying that the shell is elongated, turreted, and greatly restricted at the sutures, and the predominant spiral sculpture consists of many, thin, rounded keels as many as 7 or 8, instead of the three, prominent keels as in *Seila* proper. The shell also is thin and translucent. There is no great difference in the aperture, except that it is longer and more rounded, the columella is similar; that is, it is broad and short, the canal is also short, and the base smooth and excavate.

Seilarex turritelliformis (Angas). (Fig. 32.)

Hedley's Check-List, 1918, No. 577.

This is not an uncommon shell on the ocean beaches, both north and south of Sydney, and its features are so distinctive that its recognition is very easy. There is a slight variation in the sculpture, as in some specimens the numerous keels, instead of being alternate in size, are subequal. It is very difficult to obtain specimens with perfect protoconchs, and it is possible that study of a long series will show that there are two species instead of one. The specimen figured is from Huskisson, is of a bright red brown colour, and is 9.5 mm. in length.

Genus SEILA Adams, 1861.

The general characters include an elongate, conical shell, with flat whorls, the sutures often indistinguishable, the aperture with thin outer margin, the columella like *Cerithiopsis* flat, broad and short, the base smooth and excavate, protoconch varied, but with the nucleus infolded, the sculpture of three spiral keels with a fourth on the body whorl, the surface of the keels smooth and unbroken, the transverse sculpture confined to minute striations between the keels.

Within these limits all the New South Wales species are very nearly similar, and the differences are small but quite constant. The protoconch is the ultimate test of specific difference, the sculpture hardly varies at all, but size, colour and apical angles are useful in distinguishing the species.

Seila albosutura Tenison-Woods.

Hedley's Check-List, 1918, No. 574.

I have been unable to identify this species from among the material available. The original description is brief and inadequate, but the character which should aid recognition is the purplish brown colour with a pale white band just above the suture. Angas described *Cerithiopsis purpurea* from Port Jackson, dredged off Shark Island, and Hedley in his Check-List synonymised this under *albosutura*, but as to whether *purpurea* should be restored I can express no opinion. One or other name must be included in the local fauna.

In the absence of specimens the original description by Angas is given in full as follows: "Shell elongately acuminated, moderately solid, purplish brown with the last rib in each whorl grey; whorls 11 or 12, encircled with rounded, equidistant ribs, 4 to a whorl, the last smaller, an extra rib on the base of the last whorl, which is flattened and very minutely striated, the interstices finely longitudinally striated, nuclear whorl sinistral; aperture quadrately ovate; outer lip thin; columella arcuate and produced in front. Length 3½ lines, breadth 1 line. This species differs from *C. crocea,* in being smaller and more cylindrical, with a narrower base, in its style of colouring, and in having the lateral outline less rectilinear".

Several characters given here do not fit any of the other species here dealt with. Angas's figure shows the whorls slightly rounded, a character confirmed in his comparison with *crocea;* the colour seem distinctive, and there would seem to be an extra keel on each whorl. Reference to a sinistral whorl is puzzling, but the species would seem to have a short protoconch, otherwise it would have been remarked. Angas mentions that a variety occurs of a pale livid brown colour, and possibly this is one of the other species here described. A tube in the Australian Museum collection is labelled *Cerithiopsis purpurea,* but the specimens were with one exception very worn and had no protoconchs. The exception was a specimen of a very slender species which is described in this paper as *Seila tenuis.* (Fig. 38.)

Seila maculosa, sp. nov. (Fig. 33.)

Shell of medium size, elongately conical, spire even and flat, colour purplish brown, variegated with cream. Protoconch small of 2 whorls, plus an infolded nucleus, the whorls short and comparatively broad, smooth, glassy and yellowish. Mature whorls 9, flat, sutures distinguished by a faint thread caused by the overlap of the fourth keel. Sculpture three, prominent, equal keels, with narrow, rounded summits, a fourth keel on the body whorl, transverse sculpture confined to minute striations between the keels. Base excavate and smooth. Aperture short, subquadrate, outer margin thin and indented by the keels, columella short, broad and truncate, canal short, hidden by the columella. Length 8 mm.

Localities: The Beach, Huskisson, Jervis Bay (type); 14 fathoms off Long Reef.

Remarks: This species is based on the distinctive protoconch, but the variegated colouring should be a useful recognition point. An immature specimen from Manly Beach has a somewhat similar protoconch, but is evenly deep red brown in colour. It is very near, if not the same species.

Seila crocea Angas. (Figs. 34, 34a.)

Hedley's Check-List, 1918, No. 575.

The exact identity of this species has been difficult to determine. It appears on both the New South Wales and Tasmanian lists, and the type was dredged in Port Jackson. In many dredgings in Port Jackson no specimen approaching this species has so far been obtained, but a species was found abundantly on seaweed from 25 fathoms off Bateman's Bay which approaches very closely to the original description of *crocea,* both in dimensions and colour. Unfortunately, neither does the original figure show nor the description mention the protoconch, and without this essential character the present identification must be tentative until such time as the true *crocea* is rediscovered in the type locality. With this in mind the following characters may be noted in the Bateman's Bay shell and taken until further evidence as those of *Seila crocea*:—

Shell of medium size, conical, narrow, spire regular, colour brown orange. Protoconch sharply pointed, in the line of the spire, of 3 whorls, plus an infolded nucleus, rather paler than the mature shell, smooth and glassy, sculpture appearing suddenly on the first mature whorl with no apparent varix. Mature whorls 11, flat, sutures distinguishable by a thin thread resulting from the overlap of a fourth keel. The three, spiral keels are prominent and equal, their summits narrow and slightly flattened, transverse sculpture confined to minute striae between the keels. Base excavate and smooth. Aperture short, outer margin thin and straight, deeply indented by the keels, columella short, broad, slightly curved and narrowed anteriorly, canal short. Length 7 mm.

Seila magna, sp. nov. (Fig. 35.)

Shell very large for the group, regularly conical, colour bright orange. Protoconch unknown. Mature whorls 13, flat, increasing regularly, sutures distinguished by a narrow thread caused by the overlapping of a fourth spiral keel by the earlier whorls. Sculpture three prominent, equal, spiral keels, a fourth on the body whorl, narrowly rounded at their summits, the furrows between flattened and crossed by minute, transverse striae. Base excavate and smooth. Aperture short, outer margin straight, thin and indented by the keels, columella short, broad and truncate, canal short, hidden from in front by the columella. Length 18 mm.

Locality: Wollongong (type); collected by Miss E. Duff.

Remarks: This is the very large species found sparsely on the outer South Coast beaches, and known generally to collectors as *Seila crocea.* For years a specimen with a perfect protoconch has been sought, but so far without success. I would have hesitated to give it a new specific name had it not been for its exceptional size and its bright orange colour, characters which make its future recognition very easy. It also differs from the species taken here as *crocea* by minor details in the aperture and columella.

Seila halligani Hedley. (Fig. 36.)

Hedley's Check-List, 1918, No. 576.

This was originally described from one specimen from 111 fathoms east of Cape Byron. We have a specimen from 8-10 fathoms off Point Halliday, the one figured, and another from 14 fathoms off Long Reef. These agree very well with Hedley's description and figure, but longer series may show that more than one species is indicated. The main specific features are the pale, yellow colour, the slightly convex spire, and the 3-whorled protoconch with the second whorl inflated. The sculpture is as in the other species, but the specimen figured

has portion of the protoconch missing, and the pillar of the columella is rather club-shaped instead of straight as in the type. Length 4.6 mm.

Seila nigrofusca, sp. nov. (Fig. 37.)

Shell of medium size, conical, solid, spire even, colour a uniform very deep red brown, almost black. Protoconch small of one rather inflated whorl, plus an infolded nucleus, white, smooth and glassy. Mature whorls 9, increasing regularly, flat, sutures distinguished by a narrow thread caused by the overlapping of the fourth keel, which is visible on the body whorl. The three, prominent spiral keels are equal, rounded and narrowed at the summits, the furrows between are flattened and crossed by minute, transverse striations. Base excavate and smooth. Aperture short, subquadrate, outer margin thin and straight, indented by the keels, columella slightly longer than usual, broad and tapering slightly anteriorly, canal short and hidden by the columella. Length 7 mm.

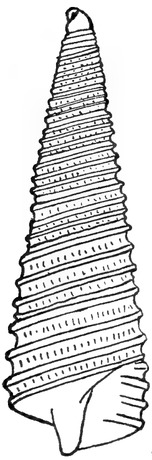
Locality: Kurnell, collected by Mr. E. F. Holland.

Remarks: This species again is based on the protoconch, and its description is otherwise very similar to that of the other species of *Seila,* though its uniform deep colouring should aid future recognition. This is possibly the shell which Angas refers to as a variety of *S. purpurea.*

Seila tenuis, sp. nov. (Fig. 38.)

Shell of medium size, conical, slender, colour pale orange. Protoconch prominent, in the line of the spire, with 3 whorls, plus an infolded nucleus, whorls rounded, white and smooth. Mature whorls 10, regular, flattened, sutures slightly indented, difficult to distinguish in the earlier whorls, but later marked by a thin thread caused by the overlapping of the fourth keel which is visible on the body whorl. The three spiral keels are evenly spaced, and in addition to the fourth keel on the body whorl, there is a slight fifth keel on the base, which is not so excavate as in other species. Transverse sculpture confined to minute threads between the keels. Aperture with thin, rounded, outer margin, indented by the keels, columella broad, rounded anteriorly and behind, canal short and broad, visible from in front. Length 6 mm; maximum breath 1.4 mm.

Locality: Middle Harbour, Port Jackson; collected by the late Charles Hedley. Specimen in Australian Museum, No. C32490.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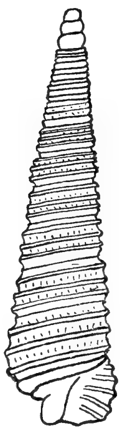
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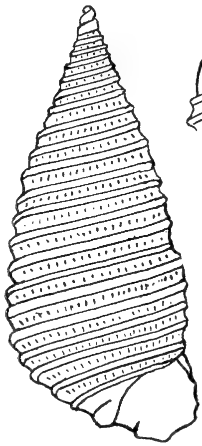
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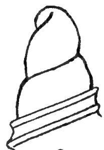
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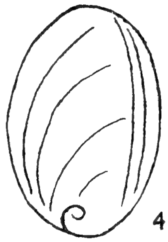
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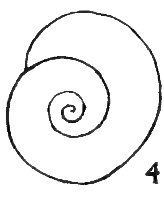

41

(For explanation of figures see page 368)

Remarks: The type was picked from a tube of worn specimens labelled *Cerithiopsis purpurea* Angas from which it was readily separated. The protoconch resembles the shell we have taken for *S. crocea,* but this is a much slenderer form, has a different columella and an extra keel on the base.

PARASEILA, gen. nov.

Genotype *Paraseila heronensis,* sp. nov.

A genus of the Cerithiopsidae allied to *Seila,* but with a convex spire and sculpture continuous on the base.

Though a Queensland shell, opportunity is taken to include it in this paper, as in a way it completes the sequence of genera. There is here an almost exact analogy with *Joculator,* for the characters which separate *Joculator* from *Cerithiopsis* separate *Paraseila* from *Seila. Joculator* in its extreme, almost globular form, is essentially a tropical shell, and many undescribed species have been seen from northern Australian waters. It is quite probable that similar extremes will be found in *Paraseila,* though its extension into the Peronian Province has not yet been discovered.

Paraseila heronensis, sp. nov. (Figs. 39, 39a.)

Shell of medium size, conical, spire broad and convex, colour deep red brown, almost black. Protoconch small, of two whorls, plus an infolded nucleus, the first whorl rather long and elevated, the second short, both white and glassy. Mature whorls about 7, flat, sutures not indented and indistinguishable, making the exact number of whorls difficult to determine. The spire is broad and convex and restricted towards the base, which is not excavate. The sculpture consists of three to four spiral keels on the body whorl with two extra on the base, and probably only two on the earlier whorls. The keels are prominent and high, their summits rather sharp, and a thinner keel appears at the suture of the body and penultimate whorls, but not between the earlier whorls. The furrows are about equal in width to the keels, and show minute transverse striae as in *Seila.* Aperture subquadrate and short, outer margin thin. Columella very short and broad, truncate anteriorly, canal short and very broad, visible from in front. Length 5 mm.; width 2 mm.

Locality: Living under coral blocks, Heron Island, and other reefs of the Capricorn Group. (Collected by John Laseron.)

Remarks: This is, I believe, the first shell of this type collected from Australian waters, thus precluding comparison with other species. Of the New South Wales Seilas, only *S. halligani* has a slightly convex spire, but this has the excavate base of the true *Seila.*

REFERENCES.

HEDLEY, C., 1918.—A Check-List of the Marine Fauna of New South Wales. *Journ. Roy. Soc., N.S. Wales,* 51, Supplement.

IREDALE, T., 1924.—Results from Roy Bell's Molluscan Collections. *Proc. Linn. Soc., N.S. Wales,* 49, p. 246.

MAY, W. L., 1921.—A Check-List of the Mollusca of Tasmania.

———, 1923.—Illustrated Index of Tasmanian Shells.

EXPLANATION OF FIGURES.

(See Plates xxxv. to xxxvii. and text-figure on page 366.)

Figs.
1, 1a—*Cerithiopsis jacksonensis* Laseron.
2, 2a— *quadrispiralis* Laseron.
3, 3a— *gregaria* Laseron.
4 — *angasi* Angas.
5 — *tripilia* Laseron.
6, 6a— *clava* Laseron.
7, 7a— *crassa* Laseron.
8, 8a— *hebes* Laseron.
9, 9a— *filofusca* Laseron.
10, 10a— *quinquepilia* Laseron.
11 — *cancellata* Laseron.
12 — *alternata* Laseron.
13 — *infracolor* Laseron.
14 — *septapilia* Laseron.
15, 15a— sp.
16 — *bicarinata* Laseron.
17 — *macalpinei* Laseron.
18, 18a— *georgensis* Laseron.
19, 19a— *exigua* Laseron.
20, 20a— *literalis* Laseron.
21, 21a—*Pilaflexis regularis* Laseron.
22, 22a— *oculis* Laseron.
23 —*Cerithiopsis exilis* Laseron.
24 — sp.
25 —*Binda tasmantis* Laseron.
26, 26a—*Cerithiopsis virgula* Laseron.
27 —*Joculator hedleyi* Laseron.
28 — *minor* Laseron.
29 — *nanus* Laseron.
30, 31 — *gracilis* Laseron.
32 —*Seilarex turritelliformis* Angas.
33 —*Seila maculosa* Laseron.
34, 34a— *crocea* Angas.
35 — *magna* Laseron.
36 — *halligani* Hedley.
37 — *nigrofusca* Laseron.
38 — *tenuis* Laseron.
39, 39a—*Paraseila heronensis* Laseron.
40 —*Cerithiopsis macalpinei* Laseron (Operculum).
41 —*Cacozeliana lacertina* Gould (Operculum).

Unfigured: *Cerithiopsis cylindrica* Watson, *Binda cacuminatus* Hedley and Petterd, *Seila albosutura* Ten.-Woods.

NEW FELLOWS.

At a meeting of Council on 26th April, 1951, the following gentlemen were elected Fellows of the Royal Zoological Society for their services to Australian Zoology:—

James Roy Kinghorn.

Charles Francis Laseron.

Emil Herman Zeck.

BOOK REVIEWS.

"BIOLOGY: An Introduction to Medical and Other Studies". By P. D. F. Murray, M.A., D.Sc., Professor of Zoology, University of Sydney. Macmillan & Co. Limited, London, 1950, pp. viii. + 600, 381 figures. Price: English, £1 5s.; Australian, £2 7s.

An author must feel reasonably certain that he has a definite contribution to make to the study of biology before he adds yet another book to those already available for junior University years. Professor Murray's "Biology" certainly differs from the ordinary run of such texts, for it covers a much wider field than usual. His aim was to provide attractive extra material for the exceptional and interested student. He has achieved this object, and the resulting book gives a concise review of most aspects of biology.

That the book has been written mainly for medical students is abundantly clear in a number of ways. It stresses such branches of the subject as embryology and the structure of the tissues of vertebrates, and this group of the animal kingdom receives far more attention than some of the more lowly types of animals. Although the plant kingdom receives a good deal of attention, there is, if anything, a bias towards animal biology, so that the book is of special interest to the zoologist—especially one whose field includes terrestrial animals and vertebrates. There is little of special application for the student of marine invertebrates.

After an introductory description of unicellular and simpler multicellular plants and animals, Professor Murray surveys the higher groups of plants and animals. He divides the animal kingdom into five major grades and typical animals of each grade are described in sufficient detail and so well illustrated that the book can serve as a guide to anyone wishing to dissect the animals. The gradual evolution of the higher groups of terrestrial plants and vertebrate animals is described from water-dwelling ancestors in the series of chapters bearing the general heading, "The Land Conquered". A discussion of man's status in the animal kingdom follows, together with an account of his evolution.

The chapters on cell structure and composition and vertebrate tissues are, as has already been noted, very comprehensive. So, too, is the section which deals with the biochemistry and metabolism of organisms, and there are discussions on growth and behaviour in both plants ar.d animals which make very interesting reading.

The author's specialised knowledge of embryology shows in his treatment of this subject. The inclusion in it of an account of the living processes of the developing animal and of causal embryology make it seem much more live to the reader than a straight account of the development of the various structures of the body could ever be. In fact, this is one of the outstanding parts of the book.

In a series of final chapters the author presents an interesting account of some groups of plants and animals which indulge in what is termed "irregular nutrition". Included here are accounts of the fungi, bacteria and viruses and other parasitic plants and also a number of animal parasites of various categories. The adaptations which result from the peculiar modes of life indulged in by parasites are also clearly discussed, and finally a brief account is given of symbiosis—those partnerships or organisms where each party derives some benefit from the association.

Throughout the book emphasis is laid on the application of each facet of biology to human affairs so that the reader feels the impact of the plant and animal world on his own life. This aspect of biology is all too often neglected.

The diagrams are clear and numerous, and there is a vein of humour which shows every now and then in the writing and makes the task of the reader very pleasant. The book can be thoroughly recommended to those wishing to read generally in biology or to teachers requiring a reference book covering a wide field and providing interesting background material for school syllabus teaching.

E. Pope.

"THE MAMMALS OF VICTORIA". By C. W. Brazenor. (National Museum of Victoria, Melbourne, Handbook No. 1.) 8vo., pp. 125, 1 coloured plate, numerous text illustrations. Price, 7s. 6d.

This compact and excellently produced handbook, by the Mammalogist of the National Museum of Victoria, represents a most progressive step in the educational activities of a State museum, while providing a comparatively simple and profusely illustrated introduction to the study of the mammalian fauna of the Australian continent. As such, this handy and moderately-priced handbook will be warmly welcomed not only in the home State of the fauna depicted, but by students and lovers of Nature in general. The work is necessarily restricted to specific treatment of the Victorian mammals, only two of which are exclusive to the State, as noted on page 9. In view of this, and the inclusion of many extra-State species in the section of the handbook dealing with dental characteristics of the Australian mammals, it seems evident that the comprehensive appeal of the work should be greatly enhanced by the inclusion of the habitat-range of individual species in future editions.

The illustrations by G. J. Browning are in the main both attractive and typical, thereby providing a ready means of popular identification, but in some instances the figures are over-large for the species depicted, as with the Honey Possum and Pigmy Glider. In the interests of more detailed habit and habitat notes, apart from the filling of considerable unused space, it would seem desirable to eliminate the vegetation sketches on pages 20 and 33, and that of the Rabbit-Bandicoot on page 29, while the aquatic sketch of the platypus could be transferred to the blank space opposite. Such suggestions are, of course, made in full appreciation of the work and with a constructive view to future editions. Consequently, it is suggested that consideration be given to redrawing the unattractive and somewhat disproportionate sketch of the pouch-embryo kangaroo, while the hand-web of the otherwise excellently drawn platypus might be more definitely shown as folded under the palm.

Regarding the more technical features of the handbook, including marsupial reproduction, and the dental characteristics of the egg-laying monotremes and the marsupials, some simplification of text and rearrangement of diagrams appear desirable. The use of such contrasting terms as "monophyodont" and "diphyodont" regarding dentition, without a glossary, is not in accordance with the educative aim of the work in its popular sense. However, such comments are merely made in the hope of assisting to make an excellent work even more comprehensive, and the handbook may be confidently recommended to readers of the *Australian Zoologist* as providing them with an informative introduction to the study of our indigenous mammals. The author, artist and producers of the work are warmly to be congratulated on the publication of the initial Museum Handbook on the Victorian fauna, and subsequent numbers forecast as dealing with birds, reptiles, insects and molluscs will be most welcome.

E.T.

"THE INVERTEBRATES. Platyhelminthes and Rhynchocoela. Volume II." By Libbie Henrietta Hyman. McGraw-Hill Book Co. Inc., York, Pa., U.S.A., 1951, pp. viii. + 550, 208 figs. Price nine dollars (American) or approx. £4/15/6 in Australia.

To those who have read and used volume I. of Dr. Hyman's invertebrate textbook the appearance of this second volume will be very welcome. It comprises a further three chapters of the main work and contains a general introduction to and discussion of those groups of the Animal Kingdom which have bilateral symmetry, and the various theories as to their origin from the Radiata are reviewed and criticised. In addition there follow general accounts of the various theories on the origins of such fundamental features of the Bilateria as the mesodermal tissues, the body cavities and metamerism. This section of the book is clearly

and concisely set out and gathers together material from a very wide variety of sources. It is, therefore, of great interest to the student who wishes to study the origins and relationships between the higher groups of animals as well as those betwen species, genera and families. The work is illustrated throughout by the author.

The remaining part of the book is devoted to detailed accounts of the flatworms and nemerteans. In dealing with each group Dr. Hyman gives a historical account of it as well as descriptions of its characters and classification. She also gives accounts of the anatomy, physiology, embryology, ecology, growth and regeneration and behaviour of each type of worm and an amazingly wide field is covered.

Since the flatworm phylum (*Platyhelminthes*) contains many parasitic forms such as the flukes and tapeworms there is naturally a discussion on host-parasite relationships and also on the effects of the parasitic way of life on the parasites themselves. But these aspects are not stressed and the emphasis is placed rather on phylogenetic considerations, as one would expect from an author with a background of museum experience. It is for this very reason that the book will be of great value to taxonomic workers. The very full and comprehensive bibliographies alone are of great value for the various papers, for the various papers are sorted and listed under headings such as "Historical", "General", or group headings like "Acoela", "Temnocephala", etc., which make the references easy to find.

From the foregoing account it will be realised that the book is not meant for junior grades in zoology and is written chiefly for senior students and research workers. As such it achieves its purpose and is to be highly recommended as a reference book. We look forward also to the third volume (now in press), which deals with a further number of non-coelomate invertebrates, including the Acanthocephala, Endoprocta, Rotifers and Nematodes.

E. POPE.

"ANIMAL WONDERLAND". By Frank W. Lane. Country Life Ltd., London, 1948, pp. xii.+232, frontisp. and 80 illustr. English price, 15s.

Some of the almost unbelievable things animals can do or have done are recounted in this fascinating book. The author has gone to great pains to gather his well-documented material together so that the book is packed with interest for naturalists. It is illustrated by a really remarkable collection of photographs. Some of the topics dealt with are: The senses of animals, birds versus aeroplanes, bird-anting, animal suicides, the hedgehog and fruit legend, and animal conservation and destruction.

OBITUARY.

JOHN H. CAMPBELL.

John Honeyford Campbell, C.B.E., I.S.O., who died at Ottawa, Canada, on 29th April, 1946, was born in the North of Ireland in 1866. He came to Australia as a youth, and in 1884 entered the Imperial Mint, Sydney, as a junior clerk, eventually rising to the position of Deputy Master in 1921. In August, 1925, he was appointed to take charge of the Royal Mint at Ottawa, and left Australia to take up that position in February, 1926.

Mr. Campbell was one of the original persons associated with the 1917 Memorandum of Association of the Royal Zoological Society of New South Wales when he was a Councillor. He took an active part in the affairs of learned societies and had been a member of ours for over thirty years. In 1921-22 he was President, his Presidential Address (Austr. Zool., iii., 1922, p. 3) dealing with the financing of our handbooks and other publications.

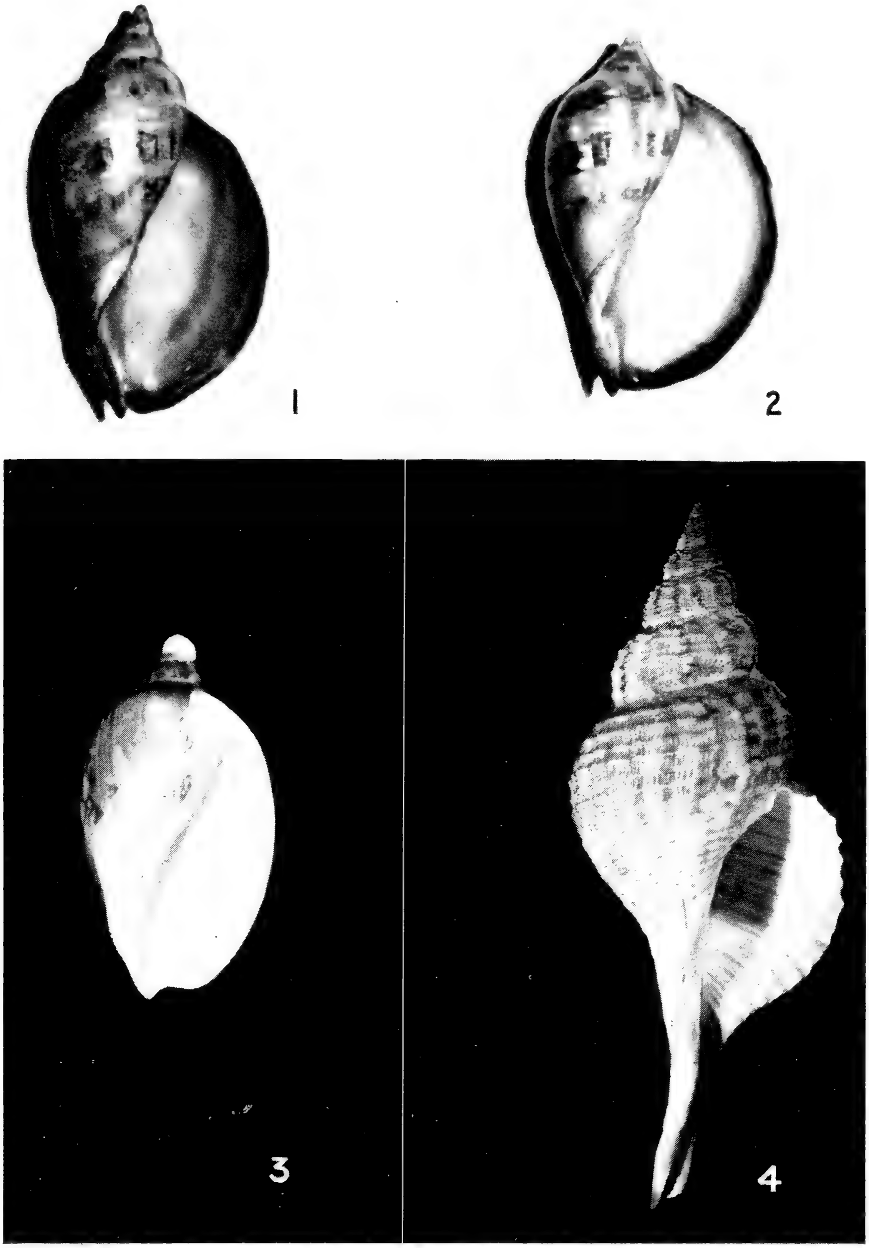
CHERRY KEARTON AND THE SOCIETY.

"That evening we were entertained by members of the Royal Zoological Society and several Fellows exhibited some extremely interesting films and lantern-slides of bird life, including egrets, lyre-birds and bower-birds. The films were accompanied by running commentaries recorded by the owners themselves, and the subjects were so interesting that I felt I had missed a great deal by not having visited Australia earlier. The function ended on a very happy note, for many copies of my books were handed round to the members, and reference was made to the fact that a number had been published by my brother and me as far back as 1890. As the chairman pointed out, I was an old friend of some forty year's standing, but it was more than gratifying to know my work was so appreciated thousands of miles away from home". Thus wrote Cherry Kearton (I visit the Antipodes, 1937, p. 31). Let us blame the war and the years which the locusts have eaten for not having noticed until now this simple and pleasant book by the well-known British naturalist.

In it Cherry Kearton also related how Messrs. John Ramsay, Neville Cayley, M. Sharland and Dr. Marshall took him to the cabin at National Park, where he enjoyed the beautiful natural surroundings, but he was disappointed that a bower was untenanted by its bird, and he was horrified by trapdoor spiders and leeches. Kearton later visited his old friend Zane Grey at Bermagui, and he recounts graphically the stories of the killer whales of Eden. "Splash", the Healesville platypus, is also dealt with by our visitor, whose book records his contacts with Nature in various parts of Australia. His epilogue ends, "It is only in the realms of poetry that one can seek and find words which do justice to the wonders of Nature, which are forever linked in my mind with Australia and New Zealand".

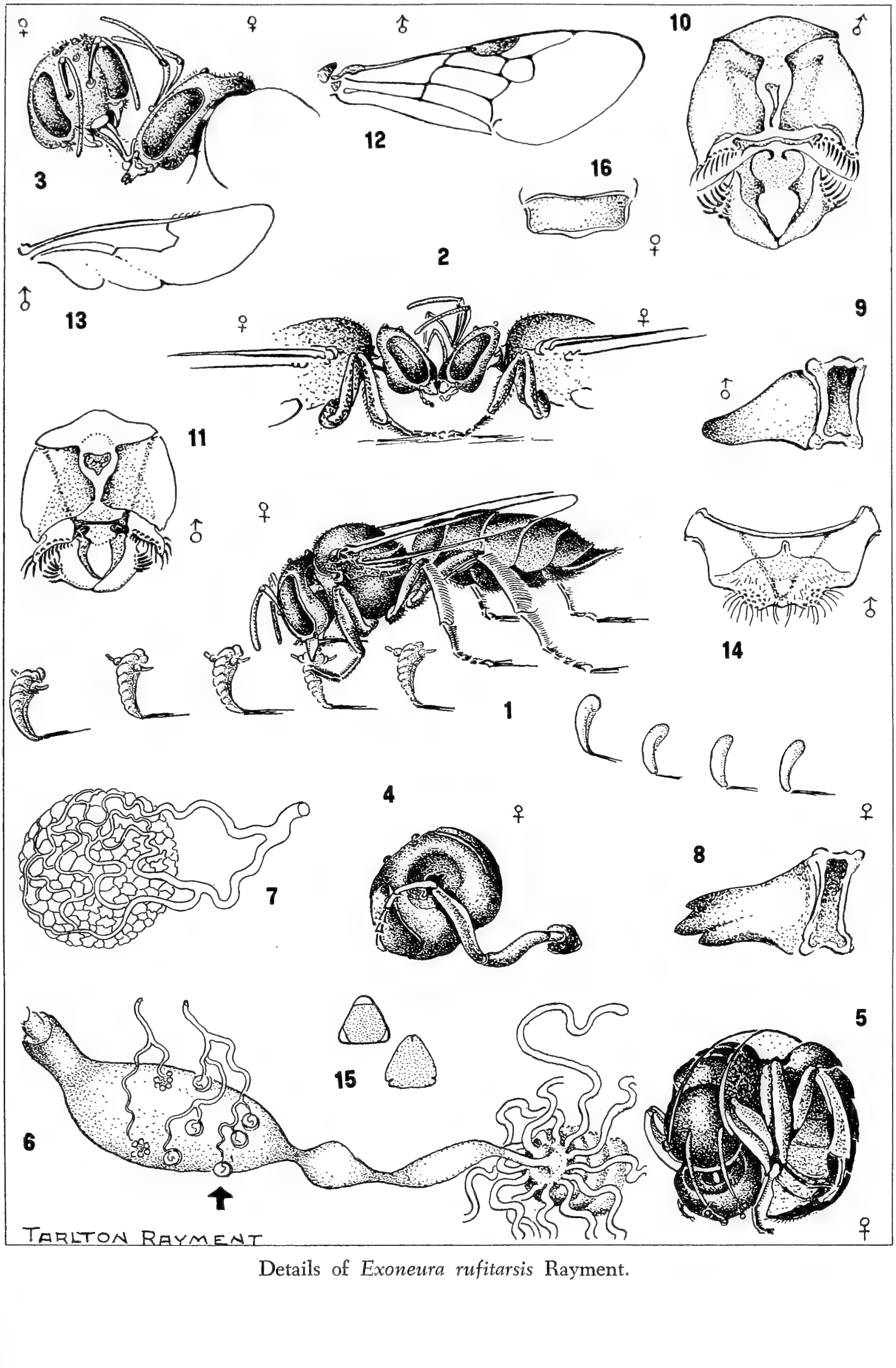
G.P.W.

☆

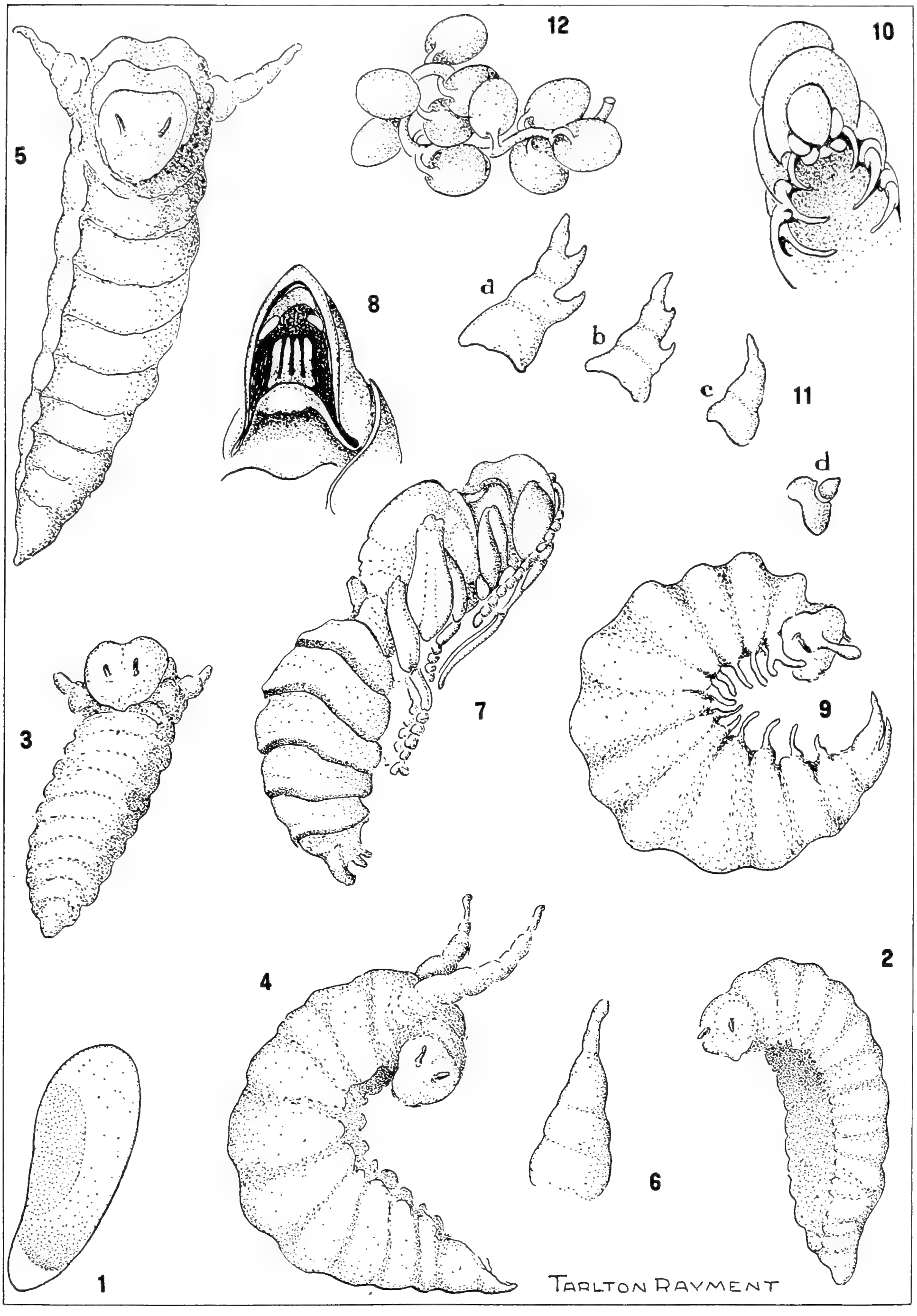


Deep-sea Shells.

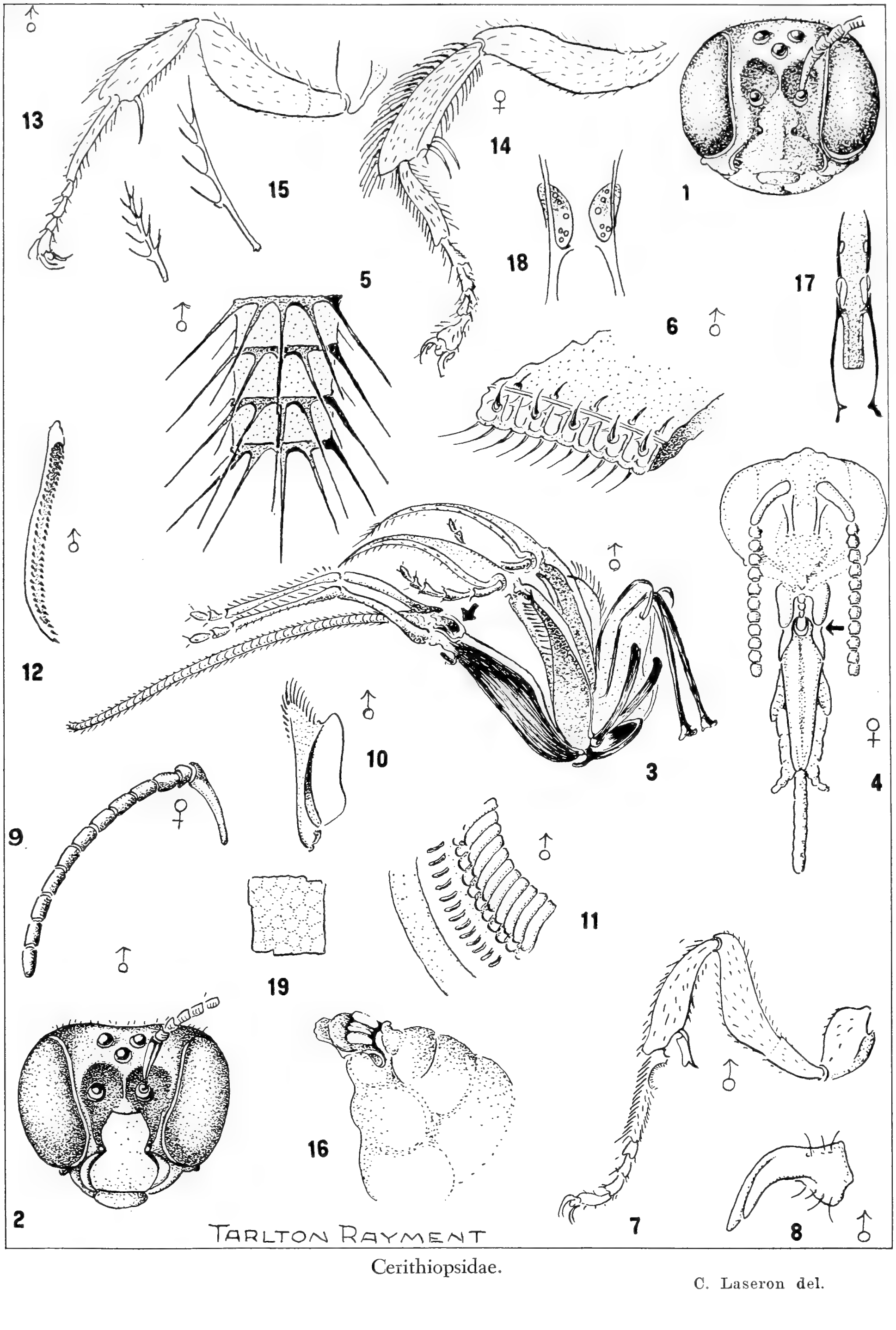
Photo.—G. McGrath.



Details of *Exoneura rufitarsis* Rayment.

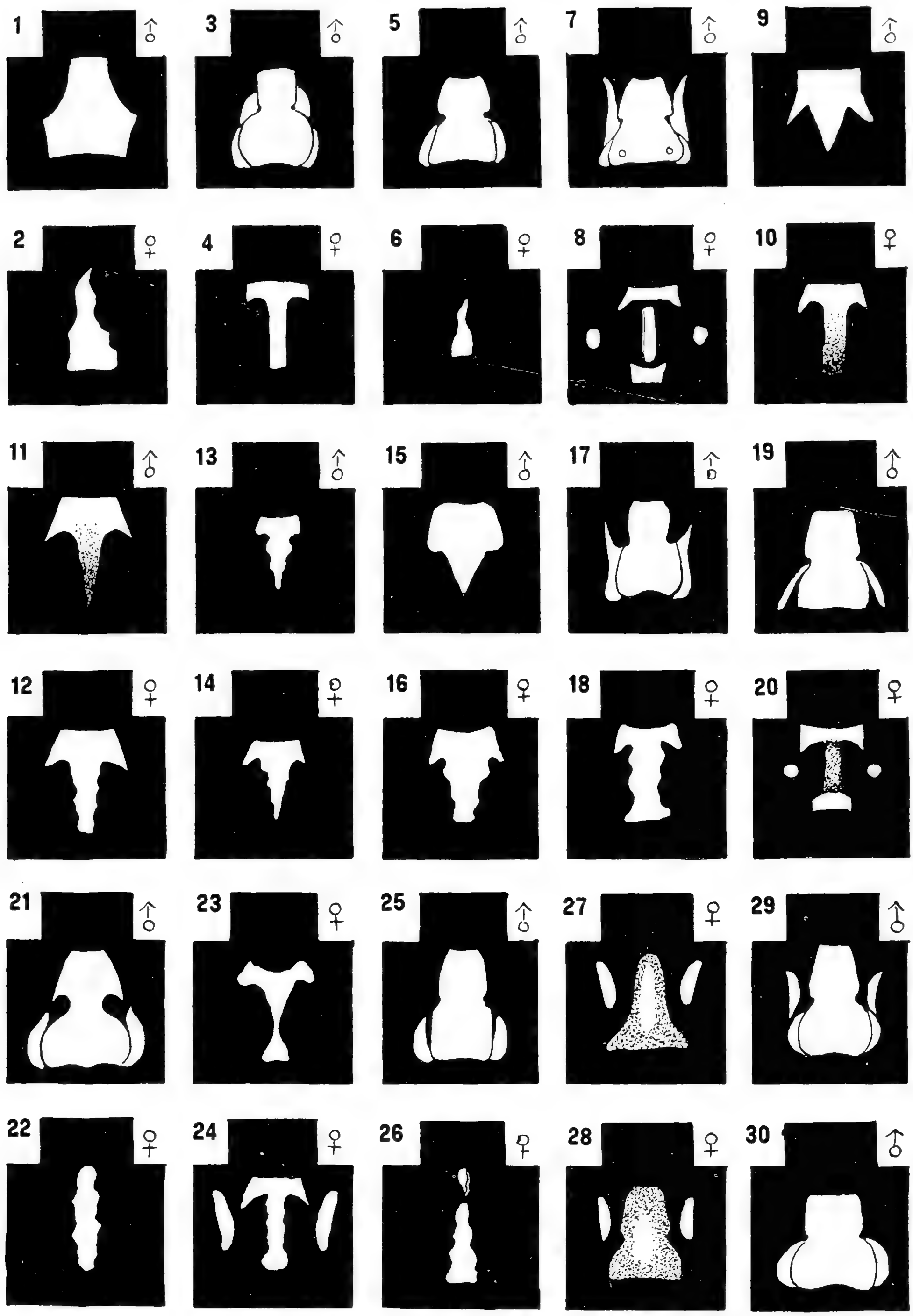


Details of larvae of *Exoneura*.

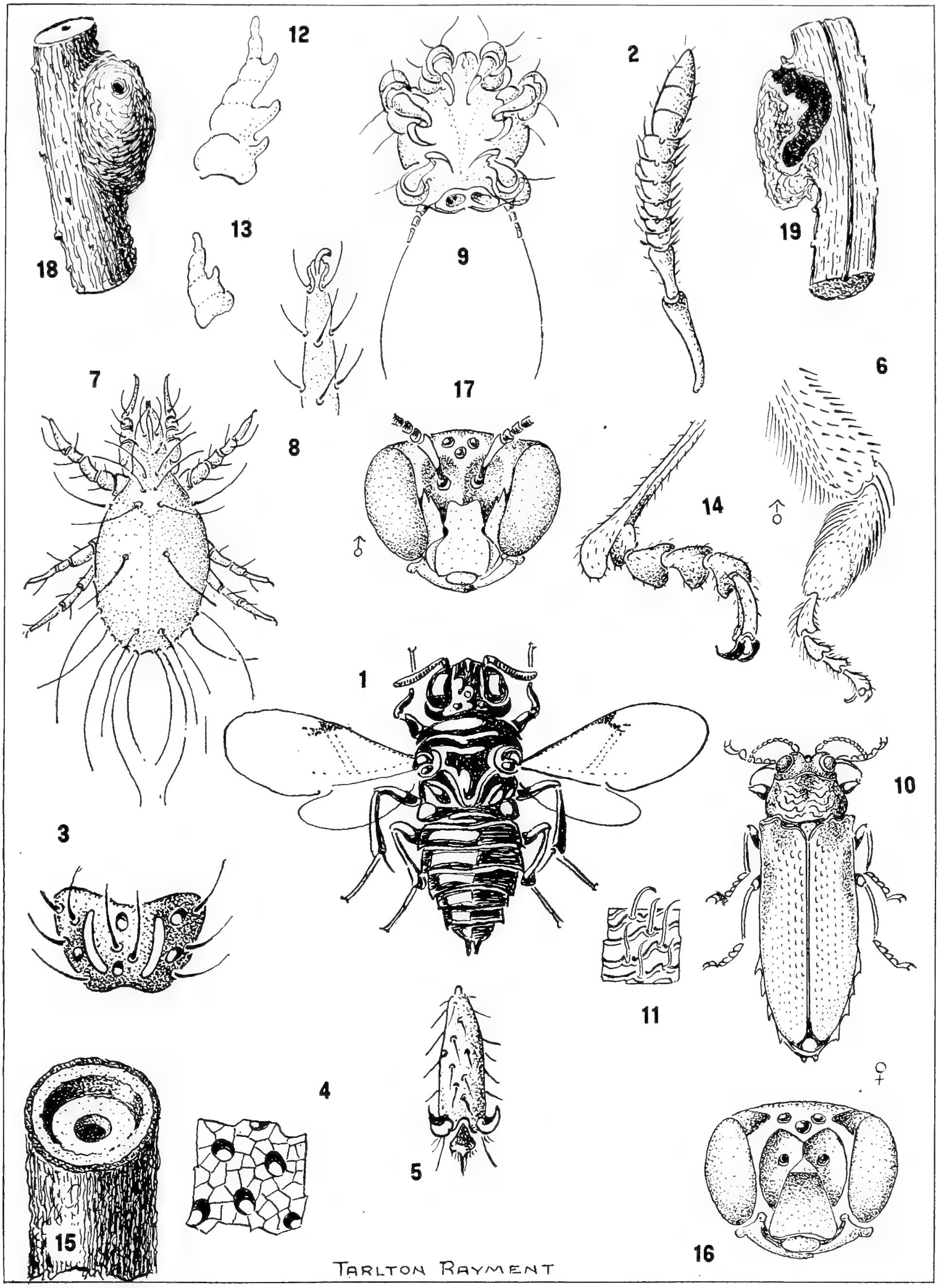


Cerithiopsidae.

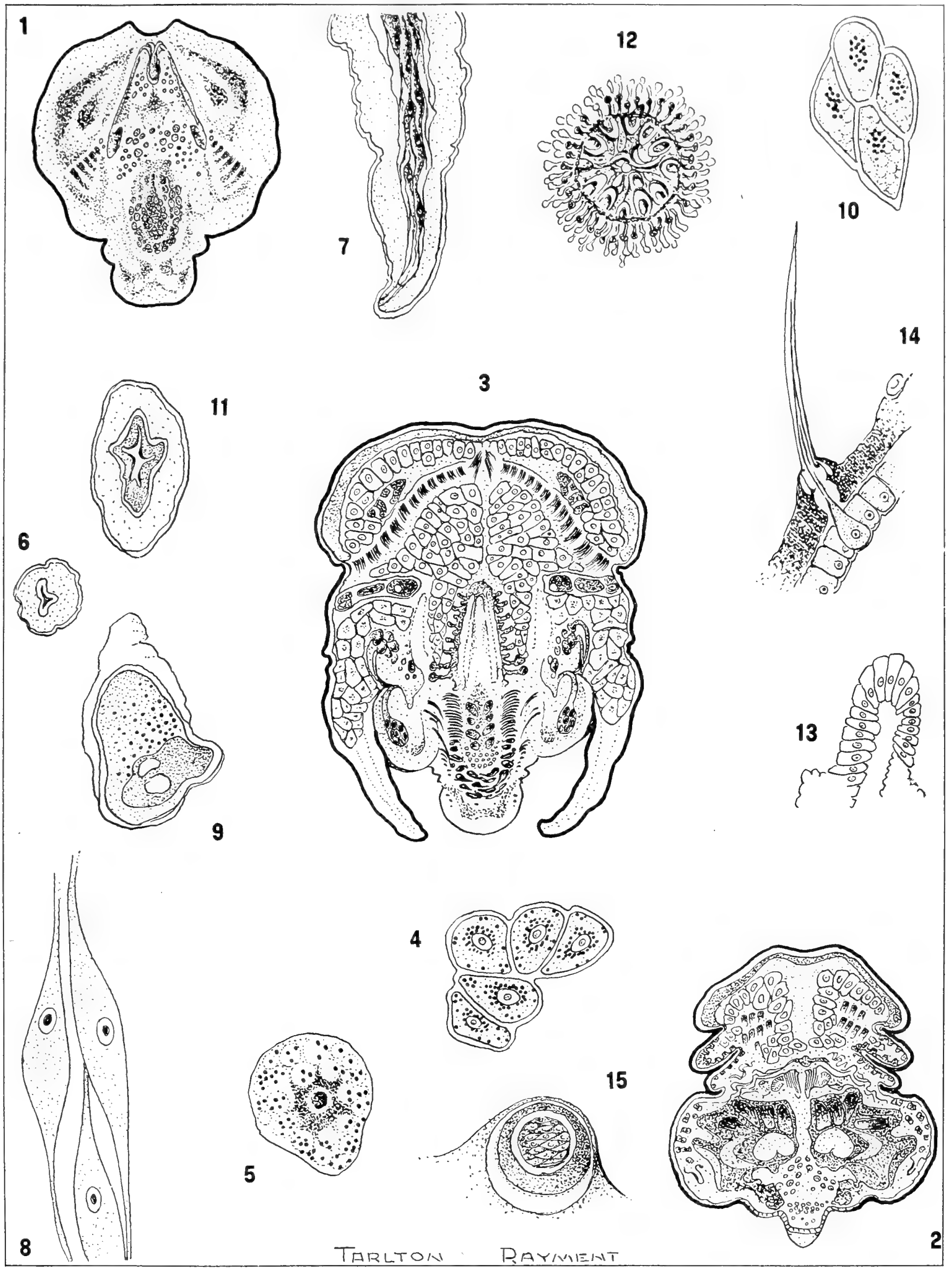
C. Laseron del.



Clypeal marks of Exoneurae.

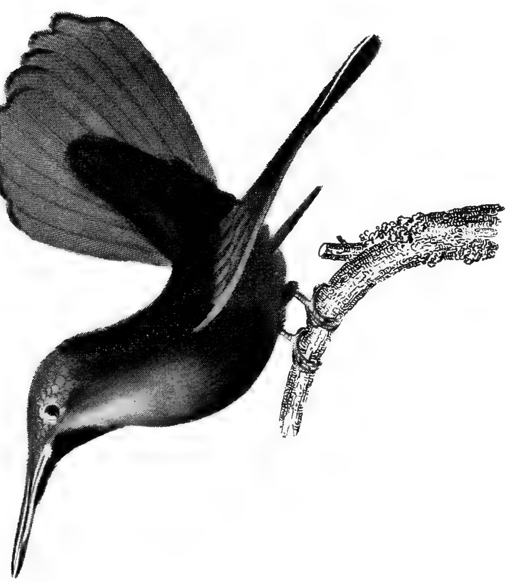


Details of *Exoneura* and its associates.



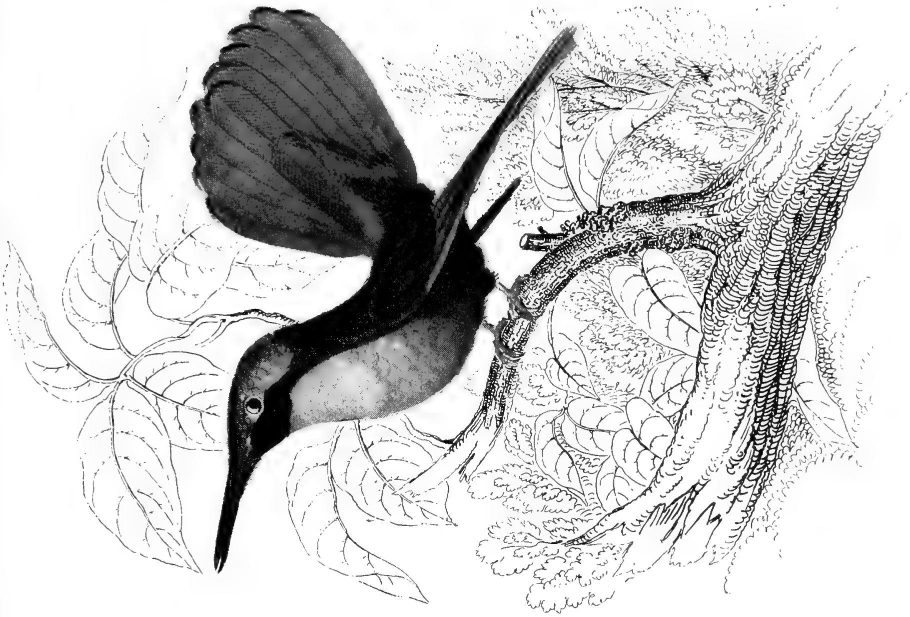
Histology of *Exoneura*.

PLATE 11



TROCHILUS MOSCHITUS.

PLATE 11.



TROCHILUS MOSCHITUS.

(Ruby-crested Humming-Bird.)

Humming Bird.

Left: Original plate. Right: Background added.

From The Naturalist's Library.

MAMMALIA.

VOL. I.

Young Rhesus Monkey

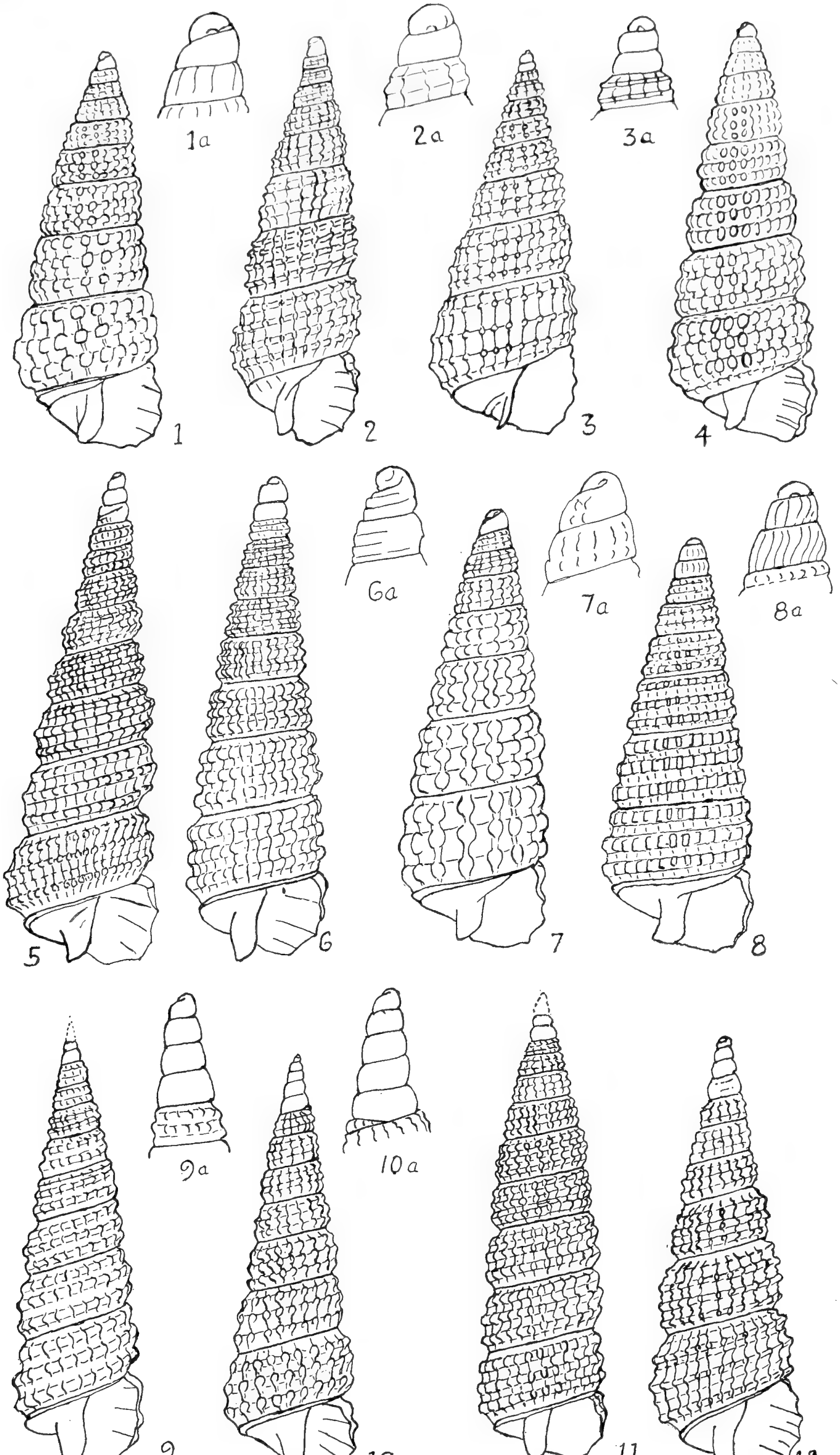
MAMMALIA.

Rhesus Monkey.
Young

Monkeys.

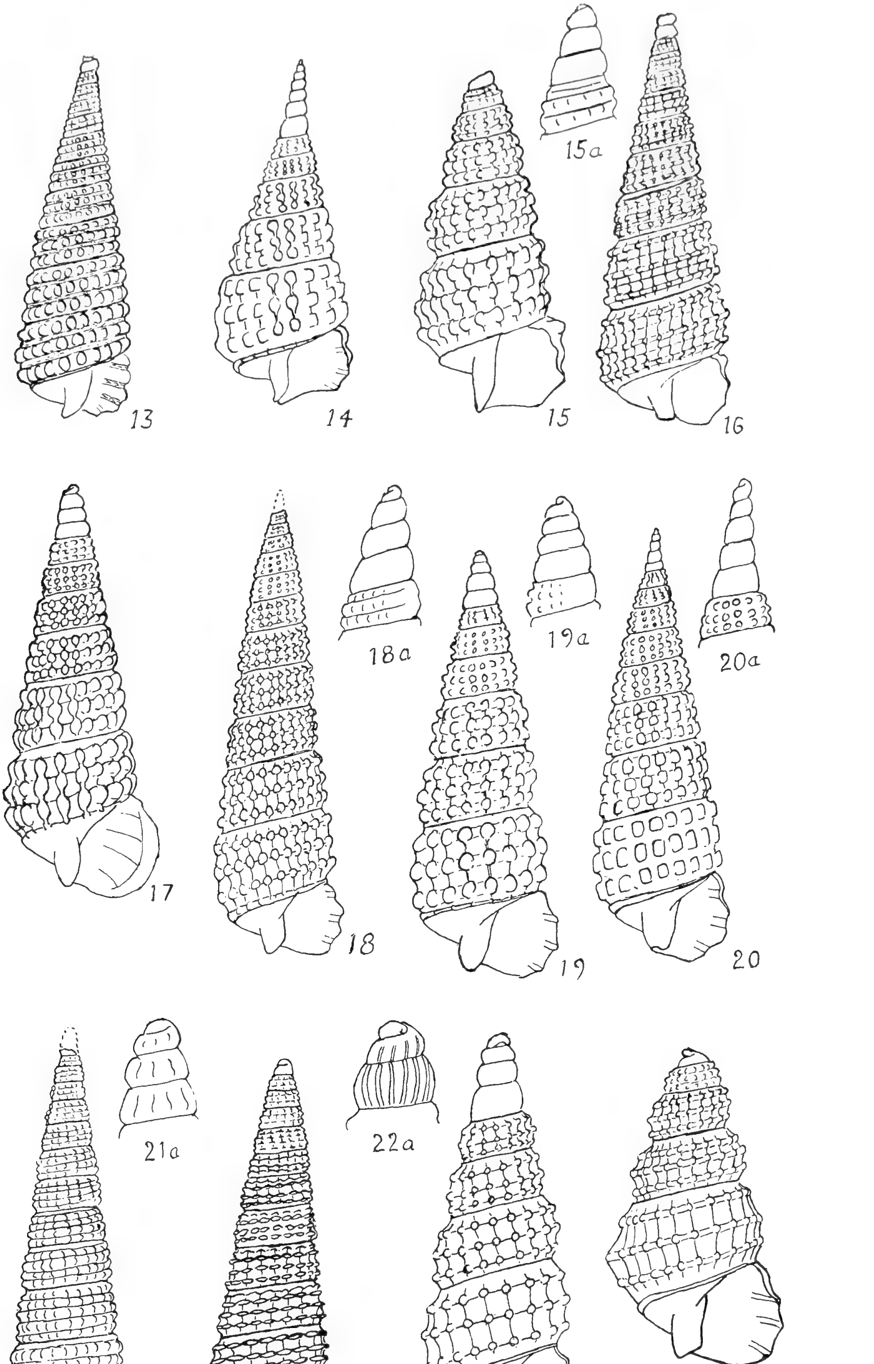
Left: Original plate. Right: Revised plate.

From The Naturalist's Library.



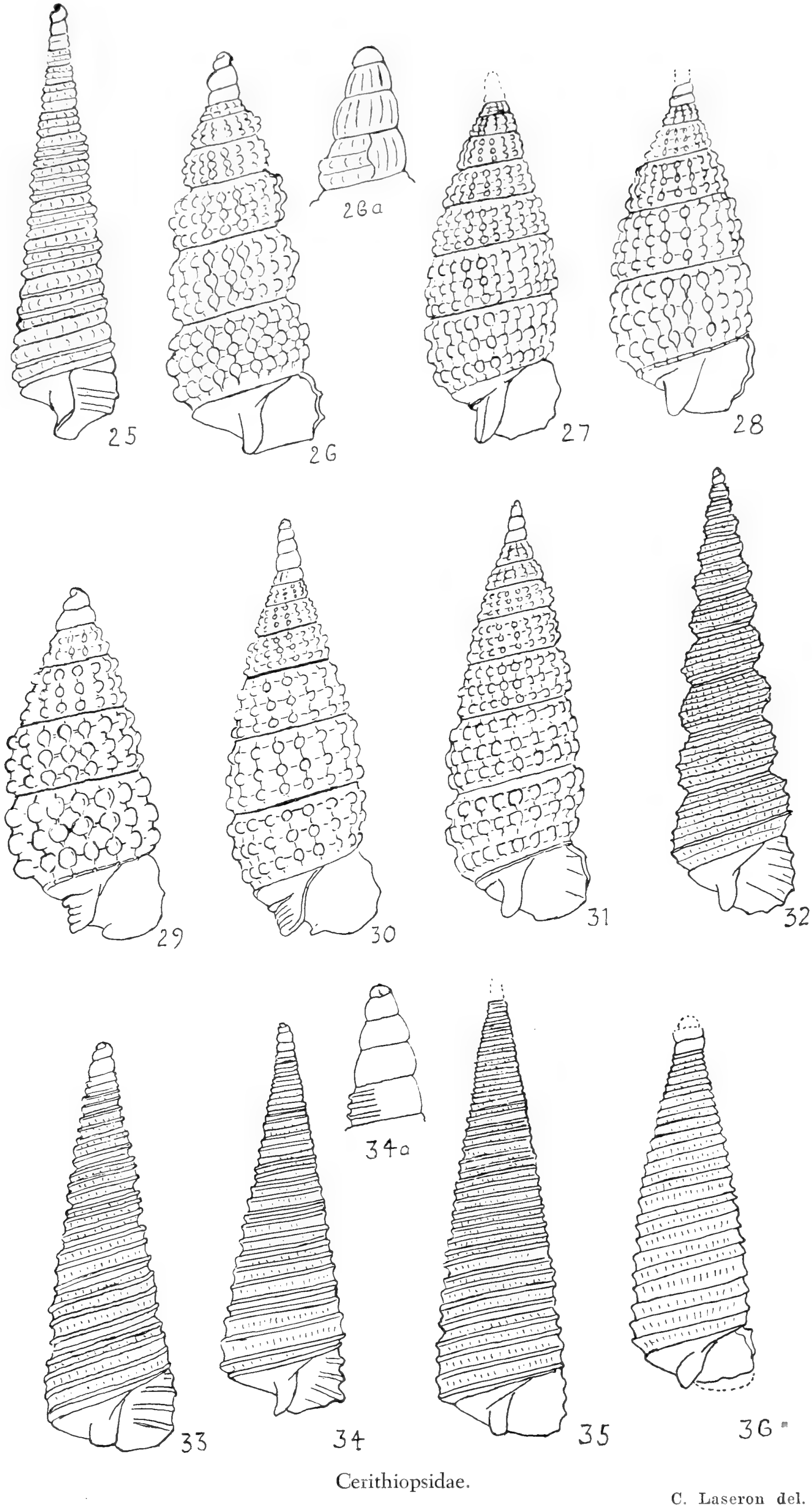
Cerithiopsidae.

C. Laseron del.



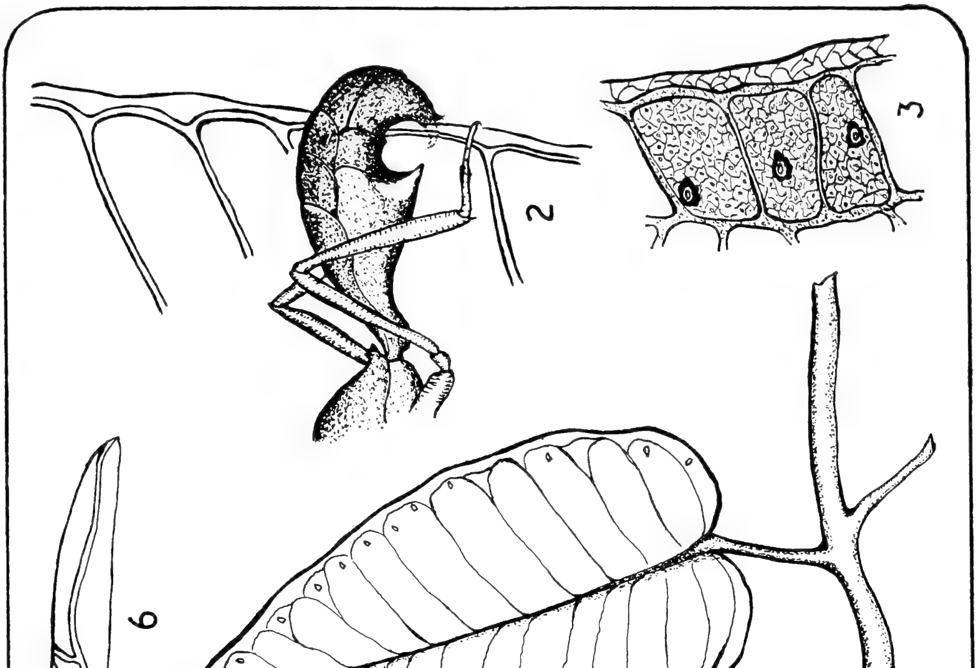
Cerithiopsidae.

C. Laseron del.



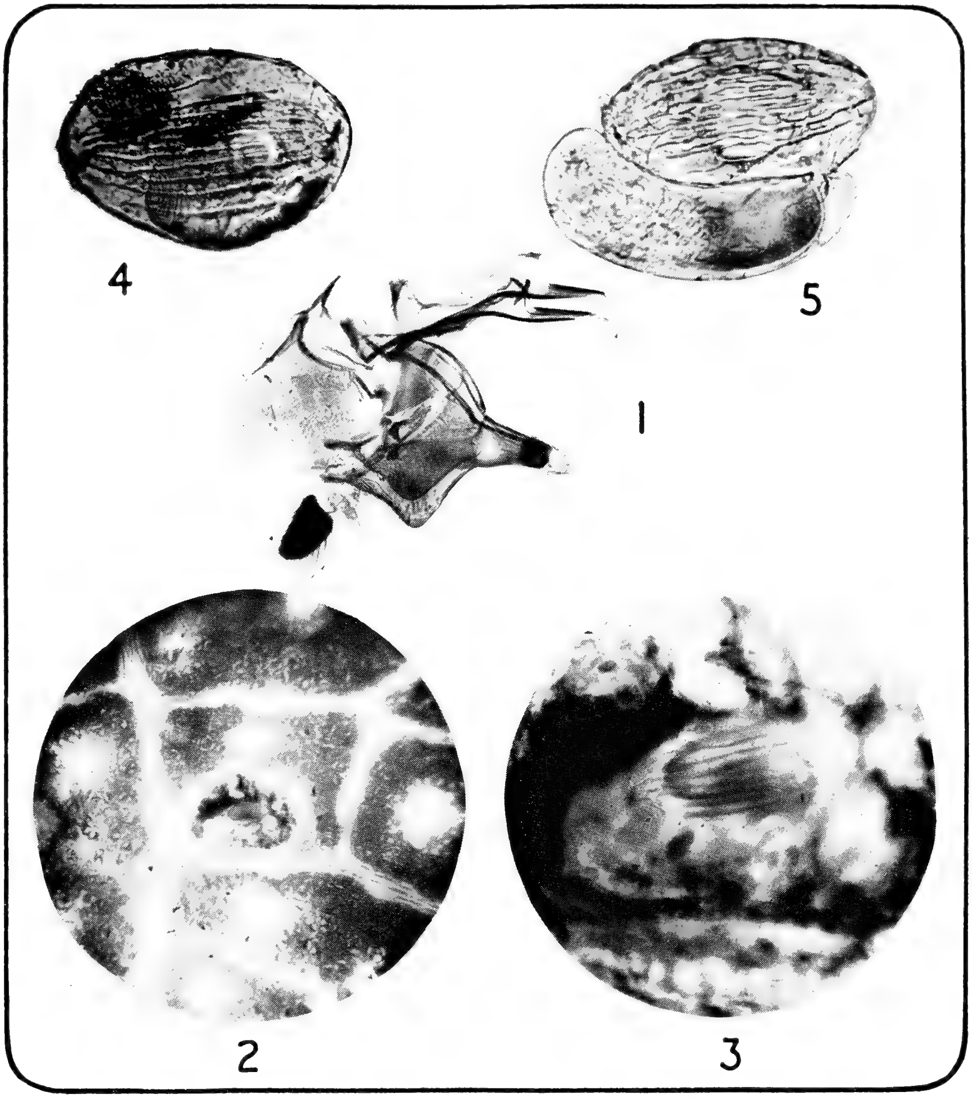
Cerithiopsidae.

C. Laseron del.



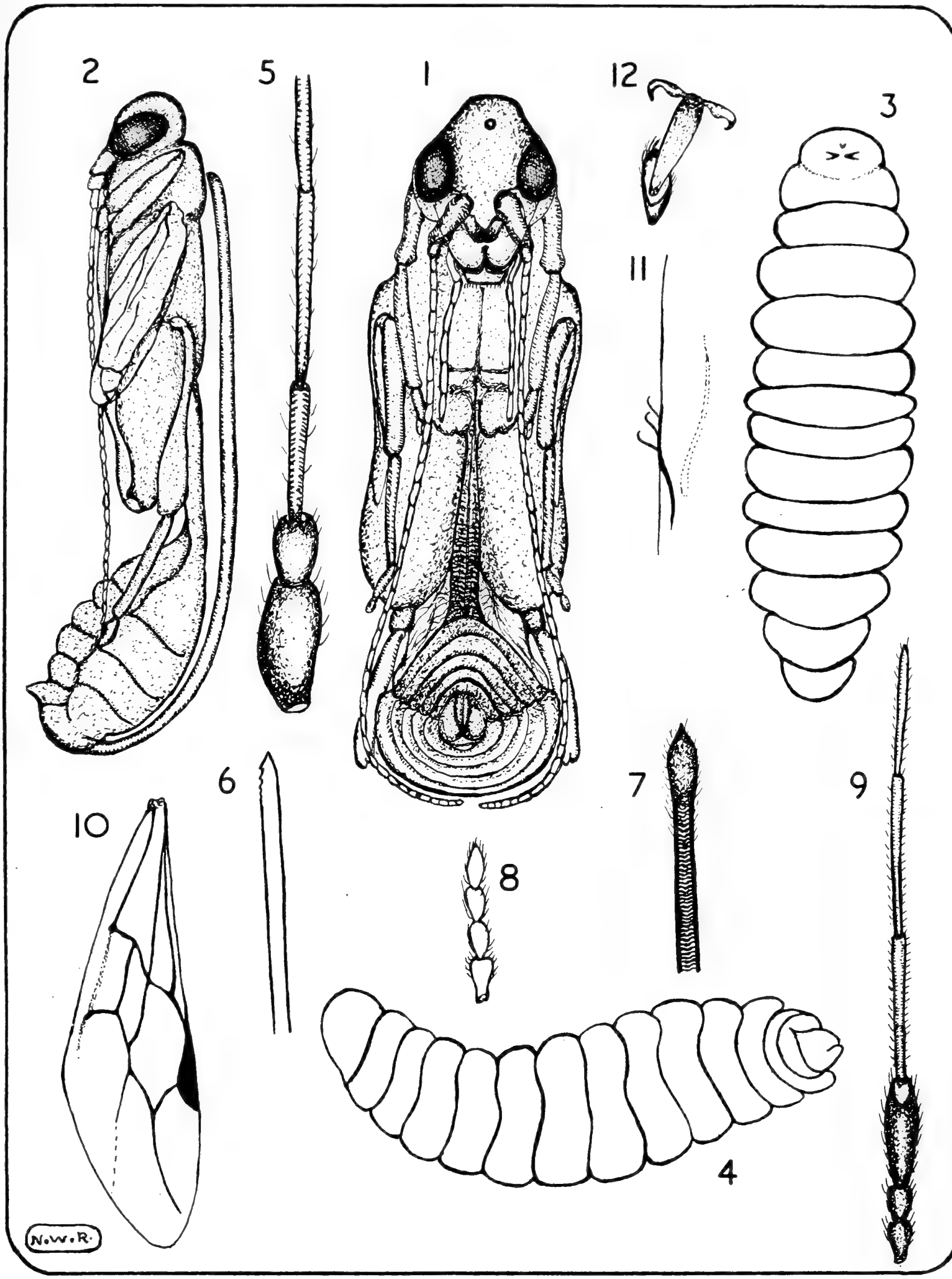
N. W. Rodd del.

Taeniogonalos.



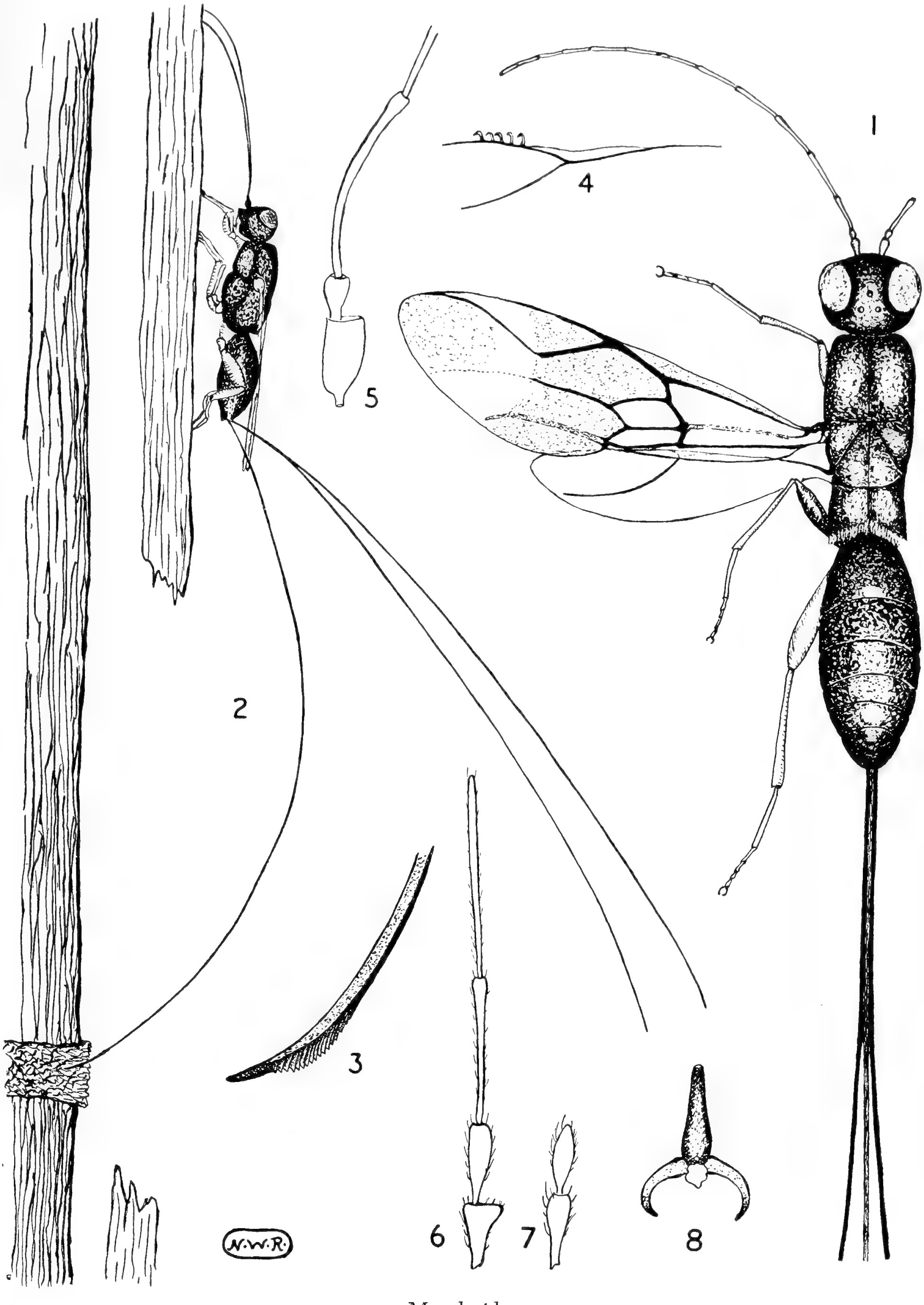
Taeniogonalos.

Photomicrographs.



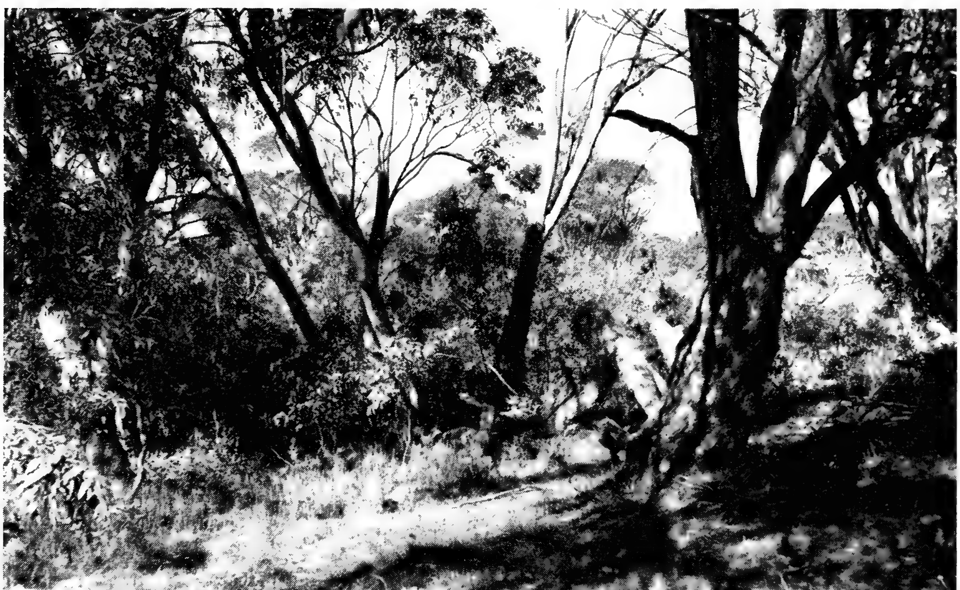
Stephanidae.

N. W. Rodd del.



Megalyridae.

N. W. Rodd del.



The Silent Cicada and its haunts.

Photos.—H. Hughes and K. C. McKeown.

ROYAL ZOOLOGICAL SOCIETY OF NEW SOUTH WALES

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Members of all classes may attend all meetings of the Society and its various Sections. Every member (other than an Associate or Life Associate member) receives a free pass to Taronga Zoological Park and Aquarium, and twelve tickets each year, admitting 12 adults or 24 children to the Park only.

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should be addressed to the Honorary Secretary, Royal Zoological Society of New South Wales, 28 Martin Place, Sydney.

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